Species Status Assessment Report for the Northern Rocky Mountains Fisher

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This document was prepared by the U.S. Fish & Wildlife Service's Northern Rocky Mountains fisher core team: James Boyd, Jodi Bush, Andy DeVolder, Bryon Holt, Jonathan Jaka, Rebecca Migala, and Justin Shoemaker.

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Species Status Assessment Report For The Northern Rocky Mountains Fisher (*Pekania pennanti*)

Prepared by the
U.S. Fish and Wildlife Service

EXECUTIVE SUMMARY

The fisher (*Pekania pennanti*) is a forest-dwelling, medium-sized mammal, found throughout many forested areas in Canada and the United States. The fisher population of interest in this report occurs in the northern rocky mountains (NRM; central and northern Idaho, western Montana, and potentially northeast Washington). The presence of a unique genetic haplotype in NRM fisher suggests historical isolation and divergence from other fisher populations in Canada and the United States.

We evaluated the status of the NRM fisher using an assessment of current condition and a plausible range of future conditions identified using the best available science. This approach allowed us to characterize viability of NRM fisher, using the biological principles of the 3 R's; resiliency, redundancy, and representation. We partitioned the NRM into three spatial units: northwest (NW), northeast (NE), and south (S) to characterize spatial distribution of modelled fisher habitat.

A species distribution model estimates about 30,000 km^2 of modelled habitat for fisher in the NRM. To date, population size of the NRM fisher has not been estimated. Therefore in this analysis, we rely on describing the amount and distribution of modelled habitat patches at two scales to make inferences about the NRM fisher. The smaller scale habitat patch is 100 km^2; the approximate size of a male fisher home range and area needed to sustain individual fishers. The larger scale habitat patch is 2500 km^2; a minimum critical area (MCA) needed to sustain 50 breeding fisher and avoid the effects of inbreeding depression.

Changes in the amount and distribution of modelled habitat for fisher are predicted to occur in the NRM in the future under varying climate change scenarios. Modest to large gains in both 100km^2 and 2500km^2 modelled habitat patches are predicted under the higher climate emissions scenario (most likely scenario to occur), with more modelled habitat shifting into the northeastern part of the NRM. Modest to small losses of both 100km^2 and 2500km^2 habitat patches are predicted under a lower climate emissions scenario, with a similar shift in modelled habitat to the north and east, but further into the future.

The prevalence of development and fire are both predicted to increase in the future in the NRM. However, little overlap between development and fisher modelled habitat is predicted. The predicted increases in frequency and severity of fire may affect individual fisher and some modelled habitat patches, but is not expected to act at the population level because fisher are

highly mobile and habitat patches are widespread, yet largely connected by contiguous canopy cover.

Other potential stressors on fisher and their habitat are forestry, trapping, poisoning and predation. These stressors are expected to remain relatively stable in the future and have varying but low effects on NRM fisher and their habitat patches at both scales, depending on future scenarios.

Modelled habitat patches that are expected to sustain fisher are currently present throughout the NRM and are expected to persist in all three fisher spatial units by 2090. Habitat patches are widespread in distribution and occupy a part of the NRM that has a distinct ash cap in the soil left from the eruption of Mount Mazama, thereby increasing the soils water retention properties and making NRM fisher habitat relatively resilient to future environmental change stemming from climate change.

Modelled habitat patches are redundant among the three fisher spatial units and this redundancy is expected to remain into the future. Representation, both currently and in the future, is predicted to remain high among all three fisher spatial units because widespread distribution of fisher genetic haplotypes, connectivity across the NRM, and the mobile nature of dispersing fisher.

Contents

CHAPTER 1. INTRODUCTION

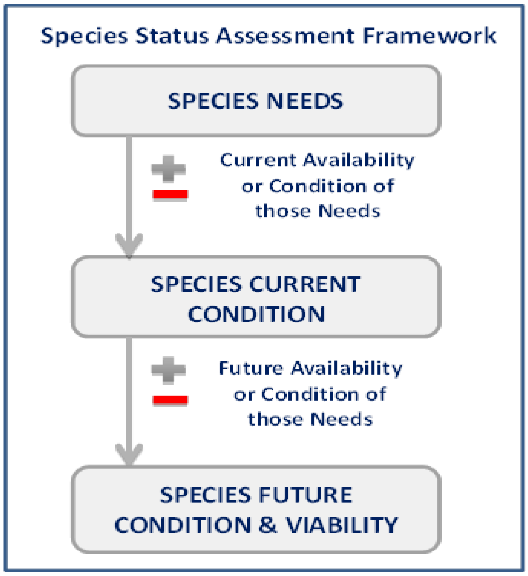
Fishers (*Pekania pennanti*) are a forest-dwelling, medium-sized mammal, light brown to dark blackish-brown in color. Fishers are found throughout forested areas in Canada and in some areas of forested habitat in the United States; specifically, the west and east coasts, the northern Rocky Mountains (NRM; central and northern Idaho, western Montana, and northeast Washington) and the Great Lakes area. The population of fisher in the NRM (hereafter, referred to as NRM fishers) was petitioned for listing as a distinct population segment under the Endangered Species Act (Act) in 2015.

The Species Status Assessment (SSA) framework (USFWS 2017, entire) is intended to support an in-depth review of the species' biology and threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain long-term viability. The intent is for the SSA Report to be easily updated as new information becomes available and to support all functions of the Endangered Species Program from Candidate Assessment to Listing to Consultations to Recovery. As such, the SSA Report will be a living document upon which other documents, such as listing rules, recovery plans, and 5-year reviews, would be based if the species warrants listing under the Act.

For NRM fishers, part of the SSA review included presentation and discussion of scientific information among interested stakeholders at three meetings held in Missoula, MT, Coeur d'Alene and Boise, Idaho. The purpose of these meetings was three-fold: (1) to increase stakeholder understanding of the Act, (2) provide an opportunity to present and discuss relevant science pertaining to NRM fishers, (3) provide the Service with the opportunity to ask specific questions about any science that was provided at the meetings. Summaries of the science and accompanying discussion were drafted from each of the meetings and were used in the development of the SSA report, along with any other relevant information the Service received or gathered during the status review process.

This SSA Report for NRM fishers is intended to provide the biological support for the decision on whether or not to propose to list the species as threatened or endangered and, if so, where to propose designating critical habitat. Importantly, the SSA Report does not result in a decision by the Service on whether this species should be proposed for listing as a threatened or endangered species under the Act. Instead, this SSA Report provides a review of the available information strictly related to the biological status of the NRM fisher. The listing decision will be made by the Service after reviewing this document and all relevant laws, regulations, and policies, and the results of a proposed decision will be announced in the *Federal Register,* with appropriate opportunities for public input.

The outcome of an SSA is a stand-alone science-based product independent of the application of policy or regulation. It provides foundational biological information, articulates key uncertainties, and, ultimately, characterizes the species' current and future condition and viability under various scenarios and timeframes. For the purpose of this assessment, we generally define viability as the ability of NRM fishers to sustain populations over time. Using the SSA framework (Figure 1.1), we consider what the species needs to maintain viability by characterizing the status of the species in terms of its resiliency, redundancy, and representation (Wolf *et al.* 2015, entire).



- **Resiliency** describes the ability of populations to withstand stochastic events (arising from random factors). We can measure resiliency based on metrics of population health; for example, birth versus death rates and population size. In the absence of species-specific demographics, we evaluate resiliency based on habitat characteristics across the geographical range. Highly resilient populations are better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities.

- **Representation** describes the ability of a species to adapt to changing environmental conditions. Representation can be measured by the breadth of genetic or environmental diversity within and among populations and gauges the probability that a species is capable of adapting to environmental changes. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment. In the absence of species-specific genetic and ecological diversity information, we evaluate representation based on the extent and variability of habitat characteristics across the geographical range.

- **Redundancy** describes the ability of a species to withstand catastrophic events. Measured by the number of populations, their resiliency, and their distribution (and connectivity), redundancy gauges the probability that the species has a margin of safety to withstand or can bounce back from catastrophic events (such as a rare destructive natural event or episode involving many populations).

To evaluate the biological status of NRM fishers both currently and into the future, we assessed a range of conditions to allow us to consider the species' resiliency, redundancy, and representation (together, the 3Rs). This SSA Report provides a thorough assessment of biology and natural history and assesses demographic risks, potential stressors, and limiting factors in the context of determining the viability and risks of extinction for the species.

The format for this SSA Report includes: (1) the biology and resource needs of individuals and populations (Chapter 2); (2) the historical distribution of NRM fishers and a framework for determining the distribution of resilient populations across its range for species viability (Chapter 3); (3) reviewing the likely causes of the current and future status of the species and determining which of these risk factors affect the species' viability and to what degree (Chapter 4); and (4) concluding with a description of the viability in terms of resiliency, redundancy, and representation (Chapter 4). This document is a compilation of the best available scientific and commercial information and a description of past, present, and likely future risk factors to the NRM fisher.

CHAPTER 2. INDIVIDUAL NEEDS, LIFE HISTORY AND BIOLOGY

In this chapter we provide basic biological information about NRM fishers, including taxonomic history, genetics, morphological description, and known life history traits. We then outline the resource needs of individuals and the population of NRM fishers. Here we report those aspects of the life history of NRM fishers that are important to our analysis.

2.1 Taxonomy

The fisher (*Pekania pennanti*) is classified in the order Carnivora, family Mustelidae, a family that also includes weasels, mink, martens, and otters (Anderson 1994, p. 14). Initially described as *Mustela pennanti* in 1777, taxonomists during the twentieth century placed the fisher in the genus *Martes* (Goldman 1935, pp. 176-177; Powell 1981 pp. 1, 4; Powell 1993, pp. 11-12) but kept the specific epithet *pennanti* (Hagmeier 1959, p. 185). At this time, fisher were grouped into three potential subspecies, based on slight morphological differences (Goldman 1935, p. 177). Genetic differences among the purported subspecies have been confirmed (Drew et al. 2003, p. 59; Knauss et al. 2011, pp. 10-12); however, it remains unclear if a subspecific designation is taxonomically valid. Recent genetic research has led to a reclassification of the fisher into the genus *Pekania* (Koepfli et al. 2008, p.5; Sato et al. 2012, p. 755) and shows that fishers are more closely related to the tayra (*Eira barbara*) and wolverine (*Gulo gulo*) than to other species in the genus *Martes* (Hosoda et al. 2000, p. 264; Stone and Cook 2002, p. 170; Koepfli et al. 2008, p. 5; Sato et al. 2009, p. 916; Wolsan and Sato 2010, p. 179; Nyakatura and Bininda-Emonds 2012, p 13; Sato et al. 2012, p. 754). The Service adopts this recent name change, which places the fisher in a monotypic genus. Characteristic of the genus *Pekania* is its large body size compared with *Martes* species, and the presence of an external median rootlet on the upper carnassial (fourth) premolar (Anderson 1994, p. 21).

2.2 Species Description

The fisher is a forest-dwelling, medium-sized mammal, light brown to dark blackish-brown in color, with the face, neck, and shoulders sometimes being slightly gray (Powell 1981, p. 1). The chest and underside often have irregular white patches. The fisher has a long body with short legs and a long bushy tail. Males range in length from 90 to 120 centimeters (cm), and females range from 75 to 95 cm in length. At 3.5 to 5.5 kilograms (kg), male fisher weigh about twice as much as females (2.0 to 2.5 kg) (Powell et al. 2003, p. 638). Heavier males have been reported across the range, including individuals within the NRM (Sauder 2010 unpublished data; Schwartz 2010 unpublished data); an exceptional specimen from Maine weighed 9 kg (Blanchard 1964, pp. 487–488). Fishers may show variation in typical body weight regionally, corresponding with latitudinal gradients. For example, fishers in the more southern latitudes of the U.S. Pacific States may weigh less than fisher in the eastern United States and Canada (Seglund 1995, p. 21; Dark 1997, p. 61; Aubry and Lewis 2003, p.87; Lofroth et al. 2010, p. 10).

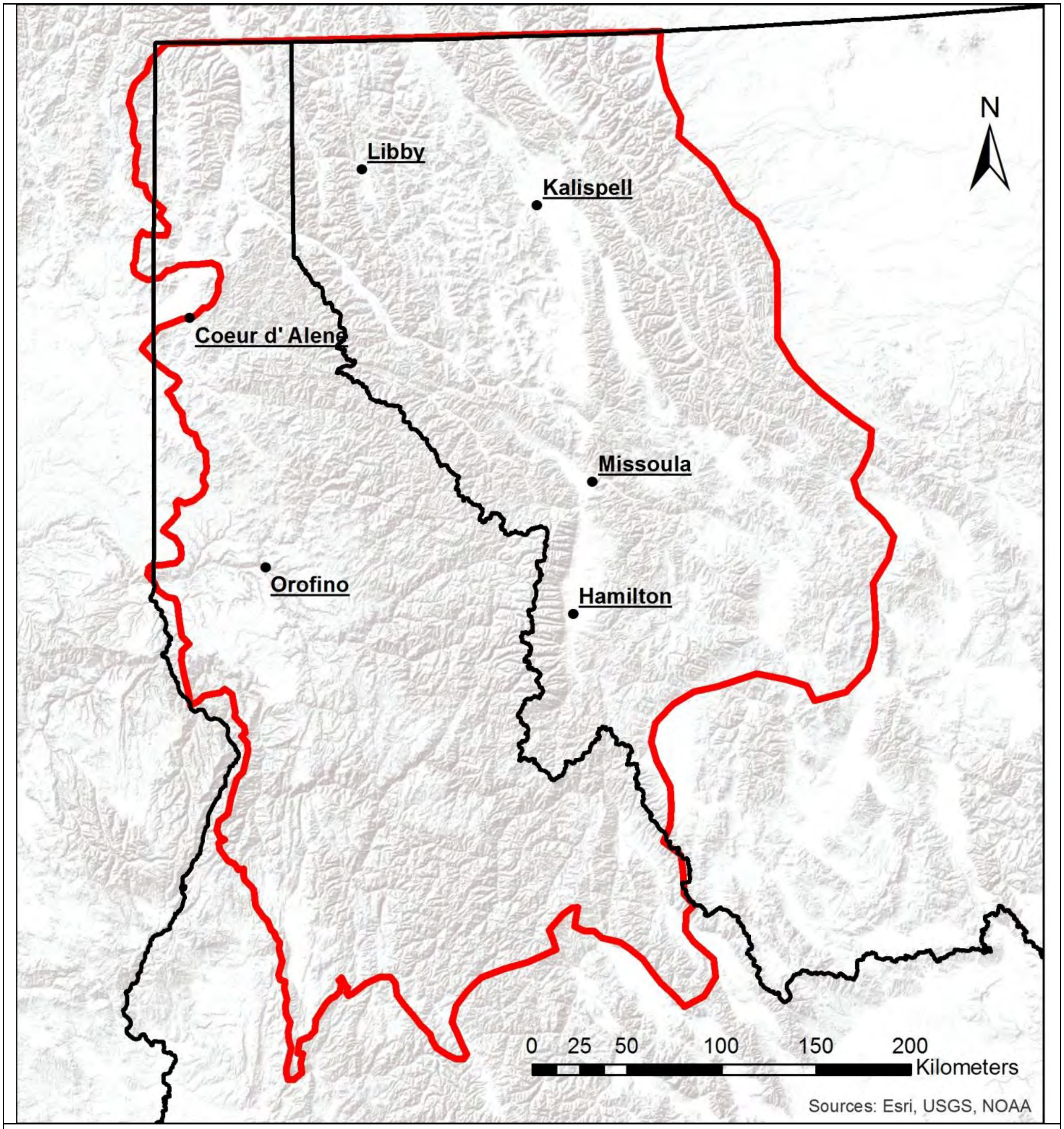
2.3 Historical Range and Distribution

Presumed historical distribution of fishers in the NRM is bounded on the east by the forested areas of the front range of the Rocky Mountains at approximately 113 degrees west longitude in Montana, the south at approximately 44 degrees north latitude, and the west in Idaho at approximately 116.5 degrees west longitude, extending to the northwest, north of the Palouse Prairie in Idaho to include the forested Pend Oreille River area of northeastern Washington (Hagmeier 1956, entire; Hall 1981, pp. 985–987; Gibilisco 1994, p. 64) (Figure 1). Some historical descriptions of distribution also include individually isolated areas in the present-day Greater Yellowstone Ecosystem (northwest Wyoming, southern Montana and east-central Idaho), and north-central Utah (Gibilisco 1994, p. 64). However, this representation of historical fisher distribution in the NRM is based on anecdotal information collected in the late 1800s to mid-1900s (Hagmeier 1956, pp. 154, 156, 161, 163; Hall 1981, p. 985), with no accompanying physical evidence or verified photographs of fishers. Therefore, we do not currently include northwest Wyoming or north-central Utah in the recognized historical distribution of fisher. Previous depictions of historical distribution of fishers drawn along boreal forest boundaries (e.g., Gibilisco 1994, p. 64) have limited accuracy and are not intended to provide any information at scales finer than the broad, distributional scale.

Montana

No reliable historical records of fisher presence are available for Montana; historical and early settlement distribution in the western forested areas of the State was assumed based on the reports of the presence of fisher in northwest Wyoming and central Idaho (Hagmeier 1956, p.

156). Vinkey (2003, pp. 44–69) investigated fisher records in the Rocky Mountains, concentrating on Montana, to determine the fisher distribution post-settlement and prior to their



Sources: Esri, USGS, NOAA

Figure 1. Presumed historical distribution of fisher in the northern rocky mountains. The red distribution line encompasses all known, verified occurrences of NRM from 1890 to present.

presumed disappearance in the 1920s (Newby and McDougal 1964, p. 487; Weckworth and Wright 1968, p. 977). The first reference to fisher in Montana was a shipping record of pelts from Fort Benton in 1875 (Vinkey 2003, p. 49). Although shipping records are not definitive of the product origin, it is likely some of the fisher pelts were of Montana origin because of Montana's prominence in the fur trade and Fort Benton's location at the upper reaches of the Missouri River (Vinkey 2003, p. 49).

Reports of fisher in Montana's Glacier National Park in the early 1900s were dismissed as ''unreliable'' and ''unauthentic'' by Newby (cited in Hagmeier 1956, p. 156); nevertheless, these records have been cited by other authors, in addition to reports from early trappers, to support a distribution of fisher in Montana as far south as Wyoming (Hoffman et al. 1969, p. 596; Vinkey 2003, p. 50). Hoffman et al. (1969, p. 596) interpreted the lack of reliable records as an indication of the fisher's extirpation in Montana and adjacent areas before any specimens could be preserved.

Idaho

The historical presence of fishers in Idaho was based on an 1890 specimen from Alturas Lake (originally Sawtooth Lake) in the Sawtooth Mountains of Blaine County in central Idaho (Goldman 1935, p. 177; Hagmeier 1956, p. 154; Drew et al. 2003, p. 62; Schwartz 2007, p. 922), and other 20th century reports of fisher in the ''mountainous parts of the state,'' including the Selkirk (north), Bitterroot (northeast), and Salmon River (central) ranges (Hagmeier 1956, p. 154). Only two fisher specimens definitively document the presence of fisher in Idaho prior to their presumed extirpation in the 1920s (Williams 1963, p. 9). The above- mentioned 1890 specimen from Alturas Lake, Blaine County has been pivotal for supporting historical distribution and post-settlement representation, because of genetic testing of the pelt and presence of the native genetic haplotype, suggesting that an indigenous population has survived since the 1920s in Idaho (Hagmeier 1956, p. 154; Hall 1981, p. 985; Drew et al. 2003, pp. 59, 62; Vinkey et al. 2006, p. 269). An 1896 Harvard Museum specimen collected in Idaho County in north-central Idaho west of the Bitterroot Divide, which separates Idaho and Montana, further supports the extent of fisher distribution in the late 1800s, and supports a close ecological connection between north-central Idaho and west-central Montana, as both areas currently contain individuals with the native haplotype (Vinkey et al. 2006, p. 269; Schwartz 2007, pp. 923– 924).

Wyoming and Utah

The first reported fisher capture in Wyoming is often cited as occurring in the 1920s from the Beartooth Plateau east of Yellowstone National Park near the Montana State line (Thomas 1954, p. 28; Hagmeier 1956, p. 163). The pelt of a poached fisher was confiscated in

Yellowstone National Park in the 1890s, but it is not clear where the animal was captured originally (Skinner 1927, p. 194; Buskirk 1999, p. 169). Fishers have been seldom described in Wyoming (Buskirk 1999, p. 169), and by the 1950s fisher were considered ‘‘extinct or nearly so’’ in the Yellowstone area (Thomas 1954, p. 3; Hagmeier 1956, p. 163). As early as the 1920s the fisher was considered rare or absent from Yellowstone National Park (Skinner 1927, p. 180). The inclusion of Utah in the historical range of the fisher was based solely on photographs of tracks taken in 1938 (Hagmeier 1956, p. 161). Given the anecdotal nature of these historic observations, we do not currently include Wyoming or Utah in the recognized historical distribution of fisher.

Location of Reintroduction Efforts in the U.S. Northern Rocky Mountains

By 1930, fishers were thought to be extirpated from the NRM in Montana and Idaho as they were in other parts of the United States (Williams 1963, p. 9; Newby and McDougal 1964, p. 487; Weckworth and Wright 1968, p. 977). Montana Department of Fish and Game (now Montana Fish, Wildlife and Parks (MTFWP)) initiated a reintroduction program for fisher in 1959 with 36 individuals from central British Columbia transplanted to the Purcell, Swan, and Pintler Ranges in northwestern and west-central Montana (Figure 2; Weckworth and Wright 1968, p. 979). Idaho Department Fish and Game (IDFG) followed with a reintroduction program for fisher in 1962, transplanting forty-two fisher from central British Columbia into areas considered to have been formerly occupied before presumed extirpation in north-central Idaho, including the Bitterroot divide area (Figure 2; Williams 1963, p. 9; reviewed by Vinkey 2003, p. 55). Minnesota and Wisconsin were the sources for 110 fisher transplanted to the Cabinet Mountains of northwest Montana between 1989 and 1991 (Figure 2; Roy 1991, p. 18; Heinemeyer 1993, p. ii). After an absence of authenticated records for over 20 years in the NRM, areas near release sites yielded fisher captures in Montana in the years following the first reintroduction efforts in 1959 (Newby and McDougal 1964, p. 487; Weckworth and Wright 1968, p. 979). No post- release studies were conducted in Idaho until the mid-1980s, but marten trappers in the State reported inadvertent captures of fisher by the late 1970s (Jones 1991, p. 1).

2.4 Current Range and Distribution

The use of unreliable records to characterize distribution has previously led to overestimation of species’ ranges, including fishers in California (Aubry and Lewis 2003, p. 86; McKelvey et al. 2008, p. 550). In this status review, we have used the most reliable and verified data to characterize the contemporary (1977 to present) range and distribution of fishers in the NRM. Verified data are from three datasets: (1) Montana Fur Harvest database (1977-2015), (2) Idaho Fish and Wildlife Information System’s Observations database (1977-2016), and (3) Martes database (2004-2016). Only data from these sources that provided physical evidence (carcass or pelt, research animal capture, DNA-validated hair sample), photographs that were positively identified by a knowledgeable expert, or observations of fishers from a trained, wildlife professional were used. Eyewitness accounts by the general public or untrained observer of a fisher, or its sign (e.g., tracks, scat), are sometimes found in agency databases or

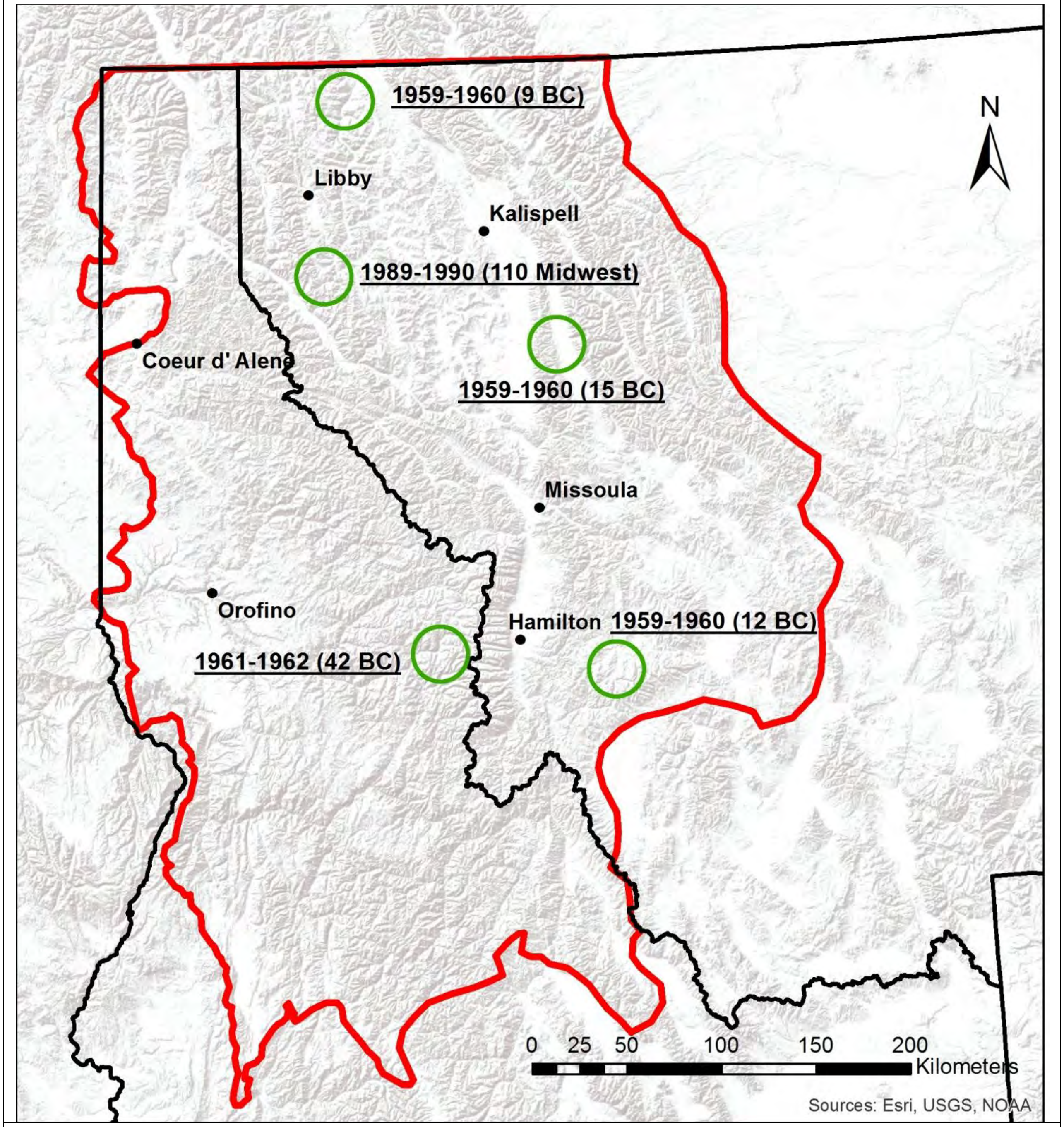


Figure 2. Locations, year and number of fisher reintroduced at sites in the northern rocky mountains. Origin of fisher for reintroductions are BC = British Columbia, Midwest = Wisconsin and Minnesota.

submitted during public comment periods (IOSC 2010, p. 5–6). However, correct identification of fishers or their sign can be difficult by an untrained observer and these unverified records or anecdotal reports should be viewed cautiously (NRMFID 2017, p. 11; McKelvey et al. 2008, p. 551; Aubry and Lewis 2003, p. 81; Vinkey 2003, p. 59) and were not included in our characterization of contemporary range and distribution. Other animals that are similar in appearance or share similar habitats, such as the American marten, mink (*Mustela vison*), or domestic cat (*Felis catus*), may be mistaken for fisher (Aubry and Lewis 2003, p. 82; Lofroth et al. 2010, p.11; Kays 2011, p. 1). Animal signs, such as tracks, can be significantly altered by environmental conditions, and fisher tracks can be confused with those of the more common American marten (NRMFID 2017, p. 11; Vinkey 2003, p. 59).

Based on the available verified specimen data, contemporary fisher distribution in western Montana and Idaho (Figure 3) covers an area similar to that depicted in the historical distribution synthesized by Gibilisco in 1994 (p. 64) (Figure 1). The contemporary distribution of fishers include forested areas of western Montana and north-central to northern Idaho, and potentially northeastern Washington. Based on a lack of verified records or documentation, we cannot conclude that the fisher is present, or was ever present, in Utah or Wyoming, including the Greater Yellowstone Ecosystem (south-central Montana, northwest Wyoming, and south-east Idaho).

Distribution of Fisher Genetics in the NRM

Genetic analyses confirm the presence of a remnant native population of fishers in the NRM that escaped presumed extirpation early in the 20th century (Vinkey et al. 2006 p. 269; Schwartz 2007, p. 924; Knaus et al. 2011, p. 7). Some fishers in the NRM still reflect the genetic legacy of this remnant native population, with unique genetic identity found nowhere else in the range of fishers. The presence of this unique genetic variation likely indicates that fishers in the NRM were isolated from populations outside the region by distance, small population number, or both, for some time before the influences that led to the presumed extirpation in the early 20th century (Vinkey 2003, p. 82).

Genetics from other fishers in the NRM reflect the genetic legacy of their pre-translocation origin (Figure 4). One such genetic legacy in NRM fishers is the presence of a genotype known from British Columbia, Canada (Figure 4). It is currently unknown whether the presence of this genotype indicates some historical connection of NRM fishers to populations further north in British Columbia or is simply an artifact from one or more historical reintroductions of fishers in the NRM using individuals from British Columbia.

To our knowledge, an assessment of the degree of introgression between native and introduced fishers has not been conducted. Analysis of genetic identity using mitochondrial

DNA only reflects the genetic contribution of the mother (Forbes and Alledorf 1991, p. 1346;

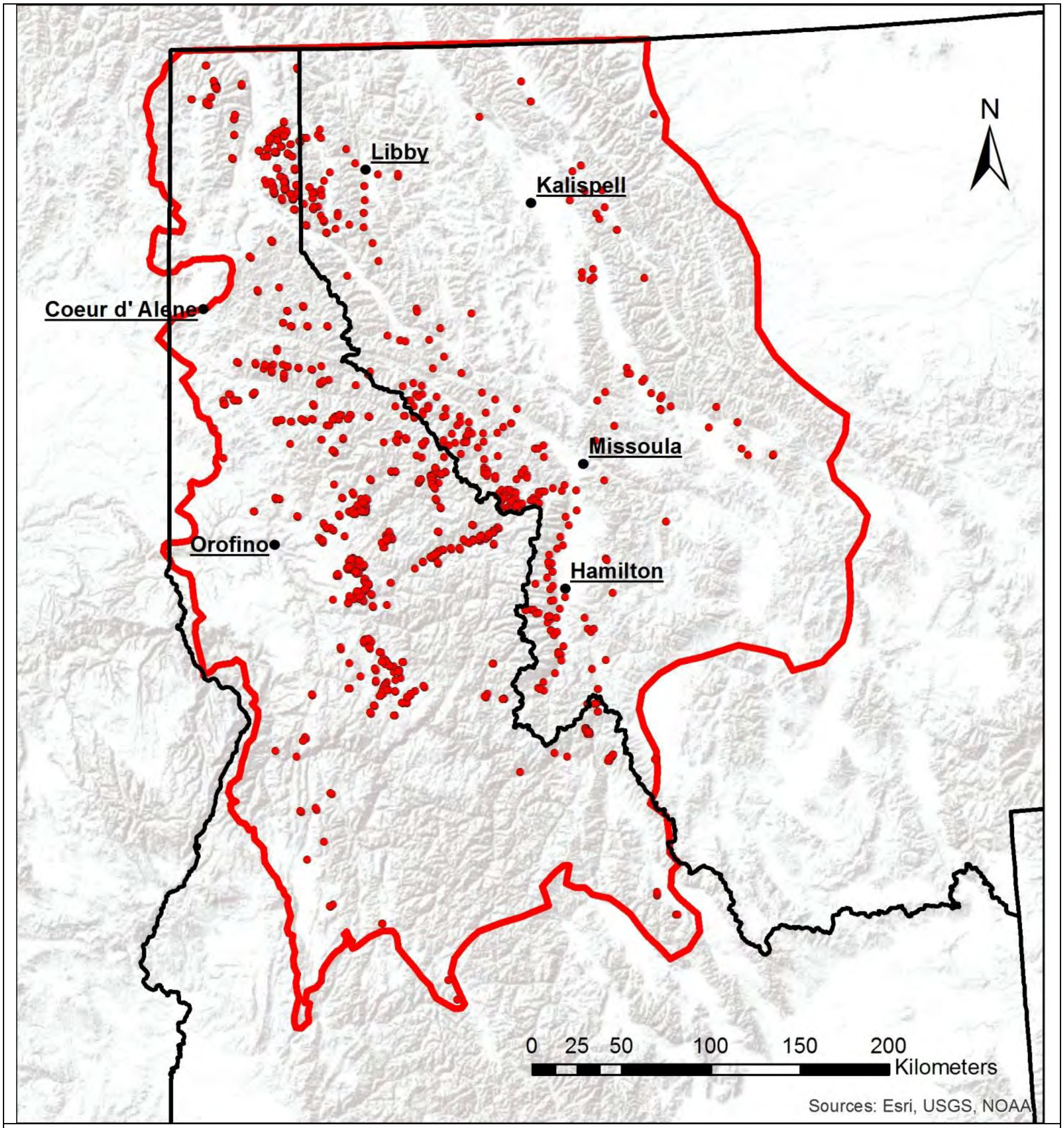


Figure 3. Contemporary fisher distribution with all known, verifiable fisher observations in the northern rocky mountains. Contemporary occurrence data are from the Montana Fur Harvest database (1977-2015), Idaho Fish and Wildlife Information System's Observations database (1977-2016), and Martes database (2004-2016).

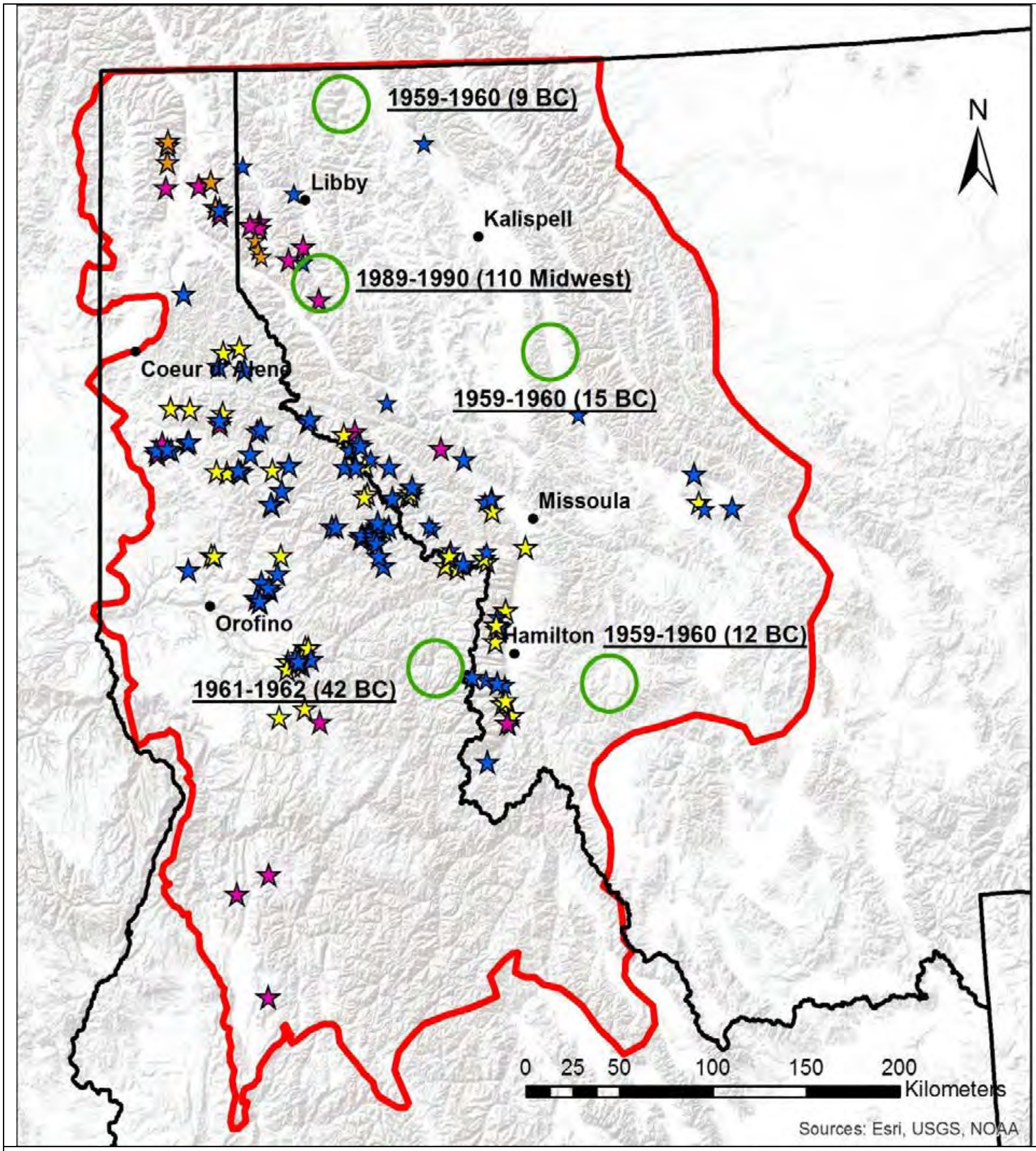


Figure 4. Locations, year and number of fishers reintroduced at sites in the northern rocky mountains relative to contemporary distribution of haplotypes. Origin of fisher for reintroductions are BC = British Columbia, Midwest = Wisconsin and Minnesota. Origin of fisher comprising contemporary distribution of haplotypes are Yellow = native, Blue = British Columbia, Orange = Midwest, and Purple = Midwest/British Columbia. Haplotype data are from the Martes database (2004-2016) and Vinkey et al. 2006.

Vinkey 2003, p. 82). Males could make a greater contribution to distant populations based on their larger home range sizes and expanded wanderings during the breeding period (Arthur 1989a, p. 677; Jones 1991, pp. 7–78), but based on mitochondrial DNA analysis alone, this contribution would not be detected.

2.5 Life History

Fishers are opportunistic predators, primarily of snowshoe hares (*Lepus americanus*), squirrels (*Tamiasciurus, Sciurus, Glaucomys*, and *Tamias* spp.), mice (*Microtus, Clethrionomys*, and *Peromyscus* spp.), and birds (numerous spp.) (reviewed in Powell 1993, pp. 18, 102). Carrion (decaying of flesh of dead animals) and plant material (e.g., berries) also are consumed (Powell 1993, p. 18). The fisher is one of the few predators that successfully kills porcupines (*Erethizon dorsatum*), and porcupine remains have been found more often in the gastrointestinal tract and scat of fisher than in any other predator (Powell 1993, p. 135). There is only one study reporting the food habits of an established fisher population in the NRM, and that study confirms that snowshoe hares, voles (*Microtus* and *Clethrionomys* spp.), and red squirrels (*Tamiasciurus hudsonicus*) are similarly important prey in north- central Idaho as they are in other parts of the range (Jones 1991, p. 87). Fishers from Minnesota relocated to the Cabinet Mountains of Montana subsisted primarily on snowshoe hare, and deer (*Odocoileus* spp.) carrion (Roy 1991, p. 29). As dietary generalists, fisher tend to forage in areas where prey is both abundant and vulnerable to capture (Powell 1993, p. 100). Fishers in north-central Idaho exhibit seasonal shifts in habitat use to forests with younger successional structure plausibly linked to a concurrent seasonal shift in habitat use by their prey species (Jones and Garton 1994, p. 383).

Fishers are estimated to live up to 10 years (Arthur et al. 1992, p. 404; Powell et al. 2003, p. 644). Both sexes reach maturity their first year, but may not be effective breeders until 2 years of age (Powell et al. 2003, p. 638). Fishers are solitary except during the breeding season, which is generally from late February to the middle of May (Wright and Coulter 1967, p. 77; Frost et al. 1997, p. 607). The breeding period in the NRM is approximately late February through April based on observations of significant changes of fisher movement patterns and examination of the reproductive tracts of harvested specimens (Weckwerth and Wright 1968, p. 980; Jones 1991, pp. 78–79; Roy 1991, pp. 38–39). Uterine implantation of embryos occurs 10 months after copulation; active gestation is estimated to be between 30 and 60 days; and birth occurs nearly 1 year after copulation (Wright and Coulter 1967, pp. 74, 76; Frost et al. 1997, p.609; Powell et al. 2003, p. 639).

Litter size for fishers range from one to six, with a mean of two to three kits (Powell et al. 2003, pp. 639–640). Potential litter sizes in the NRM are between two to three per female, based on the frequency of embryos recovered from harvested females (Weckwerth and Wright

1968, p. 980; Jones 1991, p. 84). Newborn kits are entirely dependent and may nurse for 10 weeks or more after birth (Powell 1993, p. 67). Kits develop their own home ranges by 1 year of age (Powell et al. 2003, p. 640). Reproductive rates may vary widely from year to year in response to the availability of prey (Powell and Zielinski 1994, p. 43).

An animal's home range is the area traversed by the individual in its normal activities of food gathering, mating, and caring for young (Burt 1943, p. 351). Only general comparisons of fishers home range sizes can be made, because studies across the range have been conducted by different methods. Generally, fishers have large home ranges, male home ranges are larger than females, and fishers home ranges in British Columbia and the NRM are larger than those in other areas in the range of the taxon (reviewed in Powell and Zielinski 1994, p. 58; reviewed in Lofroth et al. 2010, pp. 67–70). Home ranges of fishers in the NRM average 98 square kilometers [(km^2; 38 square miles (mi^2)] for males and 44 km^2 (17 mi^2) for females (Sauder and Rachlow 2014, p. 79.

Fishers exhibit territoriality, with little overlap between members of the same sex; in contrast, overlap between opposite sexes is extensive, and size and overlap are possibly related to the density of prey (Powell and Zielinski 1994, p. 59). Male fishers may extend or temporarily abandon their territories to take long excursions during the breeding season from the end of February to April presumably to increase their opportunities to mate (Arthur 1989a, p. 677; Jones 1991, pp. 77–78). However, males who maintained their home ranges during the breeding season were more likely to successfully mate than were nonresident males encroaching on an established range (Aubry et al. 2004, p. 215).

It is not known how fishers maintain territories; it is possible that scent marking plays an important role (Leonard 1986, p. 36; Powell 1993, p. 170). Direct aggression between individuals in the wild has not been observed, although signs of fishers fighting and the capture of male fishers with scarred pelts have been reported (Douglas and Strickland 1987, p. 516). Combative behavior has been observed between older littermates and between adult females in captivity (Powell and Zielinski 1994, p. 59).

There is little information available regarding the long-distance movements of fishers, although long-distance movements have been documented for dispersing juveniles and recently relocated individuals before they establish a home range. Fishers relocated to novel areas in Montana's Cabinet Mountains and British Columbia moved up to 163 km (100 mi) from release sites, crossing large rivers and making 700-meters (m) (2,296-feet (ft)) elevation changes (Roy 1991, p. 42; Weir and Harestad 1997, pp. 257, 259).

Juveniles dispersing from natal areas are capable of moving long distances and navigating various landscape features such as highways, rivers, and rural communities to establish their own home range (York 1996, p. 47; Weir and Corbould 2008, p. 44). In Maine and British Columbia, juveniles dispersed from 0.7 km (0.4 mi) to 107 km (66.4 mi) from natal areas (York 1996, p. 55; Weir and Corbould 2008, p. 44). Dispersal characteristics may be influenced by factors such as sex, availability of unoccupied areas, turnover rates of adults, and habitat suitability (Arthur et al. 1993, p. 872; York 1996, pp. 48–49; Aubry et al. 2004, pp. 205–207; Weir and Corbould 2008, pp. 47–48). Long- distance dispersal by vulnerable, less experienced individuals is made at a high cost and is not always successful. Fifty-five percent of transient fisher in a British Columbia study died before establishing home ranges, and only one in six juveniles successfully established a home range (Weir and Corbould 2008, p. 44). One dispersing juvenile female traveled an unusually long distance of 135 km (84 mi) over rivers and through suboptimal habitats before succumbing to starvation (Weir and Corbould 2008, p. 44). Individuals traveling longer distances are subject to greater mortality risk (Weir and Corbould 2008, p. 44), and few are likely to establish the stability of a home range, which improves the chance of successful recruitment (Aubry et al. 2004, p. 215).

2.6 Resource Needs and Selection Scale

In general, animals select for resources at multiple spatial scales (Owen 1972, entire; Johnson 1980, p. 69). First order selection is the selection of the geographical range or distributional scale of the species (Sauder and Rachlow 2015, p. 49; Johnson 1980, p. 69). Second order selection is selection of landscape needs to establish a home range (Johnson 1980, p. 69). At third order selection, animals select for specific habitat components within their home range (Johnson 1980, p. 69). Fourth order selection includes selection of very specific features selected for at the third order (Sauder and Rachlow 2015, p. 49; Owen 1972, entire).

Fishers exhibit resource selection similar to the generalized example above. First order selection for fisher includes low- to mid-elevation environments of mesic (moderately moist), coniferous and mixed conifer and hardwood forests (reviewed by Hagmeier 1956, entire; Arthur et al. 1989a, pp. 683–684; Banci 1989, p. v; Aubry and Houston 1992 p. 75; Jones and Garton 1994, pp. 377–378; Powell 1994, p. 354; Powell et al. 2003, p. 641; Weir and Harestad 2003, p. 74). Fishers also select against areas with little or no cover (Schwartz et al. 2013, p. 109; Sauder and Rachlow 2014, p. 81; Powell and Zielinski 1994, p. 39; Buskirk and Powell 1994, p. 286). These features occur in regions of the NRM receiving greater mean annual precipitation (Olson et al. 2014, p. 93) and having mid-range values for mean temperature in the coldest month (Olson et al. 2014, p. 93).

Snow conditions and ambient temperatures may affect fisher activity and habitat use. Fishers in eastern parts of the taxon's range may be less active during winter and avoid areas where deep, soft snow inhibits movement (Leonard 1980, pp. 108–109; Raine 1981, p. 74). Historical and current fisher distributions in California and Washington are consistent with forested areas that receive low or lower relative snowfall (Krohn et al. 1997, p. 226; Aubry and Houston 1992, p. 75). Fishers in Ontario, Canada, moved from low- snow areas to high-snow areas during population increases, indicating a possible density-dependent migration to less suitable habitats with deeper snow conditions (Carr et al. 2007, p. 633). These distribution and activity patterns suggest that the presence of fisher and their populations may be limited by deep snowfall. However, the reaction to snow conditions appears to be variable across the range, with fisher in some locations not affected by snow conditions or increasing their activity with fresh snowfall (Jones 1991, p. 94; Roy 1991, p. 53; Weir and Corbould 2007, p. 1512). Thus, fishers reaction to snow may be dependent on a myriad of factors, including, but not limited to, local freeze-thaw cycles, the rapidity of crust formation, snow interception by the forest canopy, and prey availability (Krohn et al. 1997, p. 226; Mote et al. 2005, p. 44; Weir and Corbould 2007, p. 1512).

At second order selection, fisher select various resources at the landscape scale needed to establish home ranges. Fishers are associated more commonly with mature forest cover and late-seral forests with greater physical complexity than other habitats (reviewed by Powell and Zielinski 1994, p. 52). In the NRM, fishers select for landscapes with abundant large trees (Schwartz et al. 2013, p. 109; Olson et al. 2014, p. 93), and greater than 50 percent mature (trees from 25 to 50 meters tall) forest (Sauder and Rachlow 2014, pp. 79-80) arranged in a contiguous, complex mosaic (Sauder and Rachlow 2014, p. 79). Within areas of low and mid-elevation forests, the most consistent predictor of fisher occurrence at larger spatial scales is moderate to high levels of contiguous canopy cover rather than any particular forest plant community (Buck 1982, p. 30; Arthur et al. 1989b, pp. 681–682; Powell 1993, p. 88; Jones and Garton 1994, p. 41; Weir and Corbould 2010, p. 408). In north-central Idaho, mature mesic forests of grand and subalpine fir in close proximity to riparian areas were used extensively (Jones 1991, pp. 90, 113; Jones and Garton 1994, p. 381) and fishers avoided forests with less than 40 percent crown cover (Table 1; Jones 1991, p. 90).

A unique aspect of the landscapes that fishers select for in the NRM is the presence of an ash layer in the soil profile. This ash layer was deposited after the eruption of Mount Mazama (now Crater Lake) in Oregon about 7700 years ago (McDaniel and Wilson 2007, p, 32). The ash layer is relatively thick, on average, and is more porous than mineral soil (McDaniel and Wilson 2007, p. 35). Soil porosity is important to vegetation because it has more than twice the water retention capability of underlying soils (McDaniel and Wilson 2007, p. 35). This unique feature of soils in the NRM is linked to increased forest productivity and potential resilience to drought (McDaniel and Wilson 2007, p, 32).

At third order selection, NRM fishers select heterogeneous areas with intermediate abundance of habitat edge and high canopy cover within home ranges, not necessarily areas containing more mature forest (Table 1; Sauder and Rachlow 2015, pp. 52-53). In general, composition of individual fisher home ranges is usually a mosaic of different forested environments and successional stages (Sauder and Rachlow 2015, pp. 52-53; reviewed by Lofroth et al. 2010, p. 94).

Fourth order selection includes selection of specific habitat features such as coarse woody debris, boulders, shrub cover, resting platforms, tree cavities or deformed trees (Table 1; Raley et al. 2012, pp. 243, 251; Powell and Zielinski 1994, p. 54; Lofroth et al. 2010, pp. 101–103). Rest sites may be selected for their insulating or thermoregulatory qualities and their effectiveness at providing protection from predators (Weir et al. 2004, pp. 193–194). Resting locations for fishers in north-central Idaho are predominantly in mature forest types (Jones and Garton 1994, p. 383). When fishers use younger forest types, they prefer large-diameter trees or snags that are remnants of a previously existing older forest stage (Jones 1991, p. 92). Because of this selectivity for mature forest type or structure, resting and denning sites may be more limiting to fisher distribution than foraging habitats, and should receive particular consideration in managing habitat for fisher (Powell and Zielinski 1994, pp. 56–57).

Cavities and branches in trees, snags, stumps, rock piles, and downed timber are used as resting sites, while cavities in large-diameter live or dead trees are selected more often for natal and maternal dens (Powell and Zielinski 1994, pp. 47, 56). Fishers do not appear to excavate their own natal or maternal dens; therefore, other factors (i.e., heartwood decay of trees, excavation by woodpeckers, broken branches, frost or fire scars) are important in creating cavities and narrow entrance holes (Lofroth et al. 2010, p. 112). The tree species may vary from region to region based on local influences. Den trees tend to be older and larger in diameter than other available trees in the vicinity (reviewed by Lofroth et al. 2010, pp. 115, 117). Little is known of natal or maternal den use or selection in the NRM. A habitat study conducted in north-central Idaho found no kits or evidence of denning (Jones 1991, p. 83). A female introduced into Montana’s Cabinet Mountains used a downed hollow log for a natal den only months after release, and it is likely that this suboptimal site was selected only because of the female’s unfamiliarity with the area (Roy 1991, p. 56).

CHAPTER 3. CURRENT CONDITION

In this chapter, we describe our analyses used to characterize current condition of fisher modelled habitat in the NRM. We then outline the causes and effects of potential stressors on fishers and their modelled habitat and relate those effects to the species current condition. Our discussion of the effects of potential stressors on NRM fishers focuses on the individual and population level, because the best available information suggests NRM fishers are part of one, widespread population. In addition, we utilize habitat metrics to discuss individual and population level effects on NRM fisher, in the absence of population estimates for fishers in the NRM. Lastly, we discuss the current state of resiliency, redundancy, and representation of the NRM fisher.

Table 1. Characteristics of resource needs for fisher in the northern rocky mountains.

Life Stage	Timing	Age (months)	Resources needed to complete life stage	Resource selection scale	Values	Resource function	Reference
Kit	Feb – Apr	0-3	Den	4	WRC, GF	Shelter	Schwartz et al. 2013, p. 109
			Large tree size	4	Mean DBH 107 cm	Shelter	Schwartz et al. 2013, p. 109
	Apr – Jul	3-6	Den	4		Shelter	
	Aug - Oct	7-9	Den	4		Shelter	
Juvenile	Sept – Apr	7-13	Migratory corridors	3	>40% canopy cover	Dispersal	Jones 1991, p. 90
			Adequate Prey	4	Sapling, younger forest habitat	Feeding	Jones and Garton 1994, p. 383
			Rest site	4	Platforms in stands of large diameter trees	Shelter	Raley et al. 2012, p. 243, 251
Adult	Apr - Jan	13+	Migratory corridors	2	>40% canopy cover	Dispersal	Jones 1991, p. 90
			Tree cavities	4	WRC, GF	Shelter	Schwartz et al. 2013, p. 109
			Canopy Cover	1/2	25 - 50m tall	Shelter	Olson et al. 2014, p. 93
			Canopy Cover	1/2	Intermediate abundance	Shelter	Sauder and Rachlow 2015, pp. 52-53
			Mosaic of mature forest	2	Complex, connected arrangement		Sauder and Rachlow 2014, p. 79
			Adequate Prey	4	Sapling, younger forest habitat	Feeding	Jones and Garton 1994, p. 383
			Rest site	4	Platforms in stands of large diameter trees	Shelter	Raley et al. 2012, p. 243, 251
			Montane riparian vegetation	3	Greater presence		Olson et al. 2014, p. 93
			Topographic position index	2	Greater proportion of drainages		Olson et al. 2014, p. 93
			Mean annual precipitation	1	Greater mean precipitation		Olson et al. 2014, p. 93
			Mean temp. in coldest month	1	Mid-range values		Olson et al. 2014, p. 93
			Few open areas	1	<5%		Sauder and Rachlow 2014, p. 81
	Feb - Apr	13+	Migratory corridor	2	>40% canopy cover	Dispersal/Breeding	Jones 1991, p. 90
			Den	4	WRC, GF	Shelter	Schwartz et al. 2013, p. 109
					Mean DBH 107 cm		Schwartz et al. 2013, p. 109

3.1 Fisher Spatial Units

In order to characterize spatial distribution of modelled fisher habitat (and subsequent potential carrying capacity) at a smaller scale than the whole, we divided the area of the NRM into three units: a northeast (NE) unit, a northwest (NW) unit and a south (S) unit (Figure 5). The division between the NE and NW units is the portion of highway 93 from Missoula, Montana to the Canadian border (Figure 5). The division between the two northern units (NE and NW) and the S unit is Interstate 90 (Figure 5). The spatial units were explicitly chosen for the purpose of describing spatial distribution of modelled fisher habitat (and hypothetical carrying capacity) and do not reflect any known biological/ecological differences among the different areas in the NRM because there are no clear biological population subdivisions within the NRM (Schwartz 2007, p. 924).

3.2 Modeling Fisher Habitat

Several efforts to characterize modelled fisher habitat have been conducted recently (Table 2; Lawler et al. 2012, entire; Olson et al. 2014 entire; Sauder et al. 2014, entire). Lawler et al. (2012, entire) built a bioclimatic model and mapped the data on 50 km^2 cell grids. This model was informed by rangewide distribution of fishers in North America and based on a mid-high climate emissions scenario. Using this approach, they predicted a large decrease in climatically-suitable range for fishers in the contiguous U.S. by the end of the century (Lawler et al. 2012, p. 379). However, this bioclimatic model had coarse resolution and did not account for the fine scale effects of topography (Lawler et al. 2012, pp. 379). Given that topography is a significant predictor of modelled fisher habitat in the NRM (Olson et al. 2014, p. 93) and more recent efforts (by Olson et al. 2014 and Sauder et al. 2014) are of finer spatial resolution and focused on the NRM, we did not utilize the results from Lawler et al. 2012 in this analysis and instead focus on the modelling efforts of Olson and Sauder below (Table 2).

Table 2. Characteristics of different modelling efforts estimating modelled fisher habitat in the northern rocky mountains, 2012-2014.

Model	Model variable types	Year	Region Modelled	Spatial resolution
Lawler	Climate	2012	North America	50 km
Olson climate	Climate/topography	2014	NRM	800 m
Olson full	Climate/topography/vegetative	2014	NRM	800 m
Sauder	Climate/topography/vegetative	2014	NRM	800 m

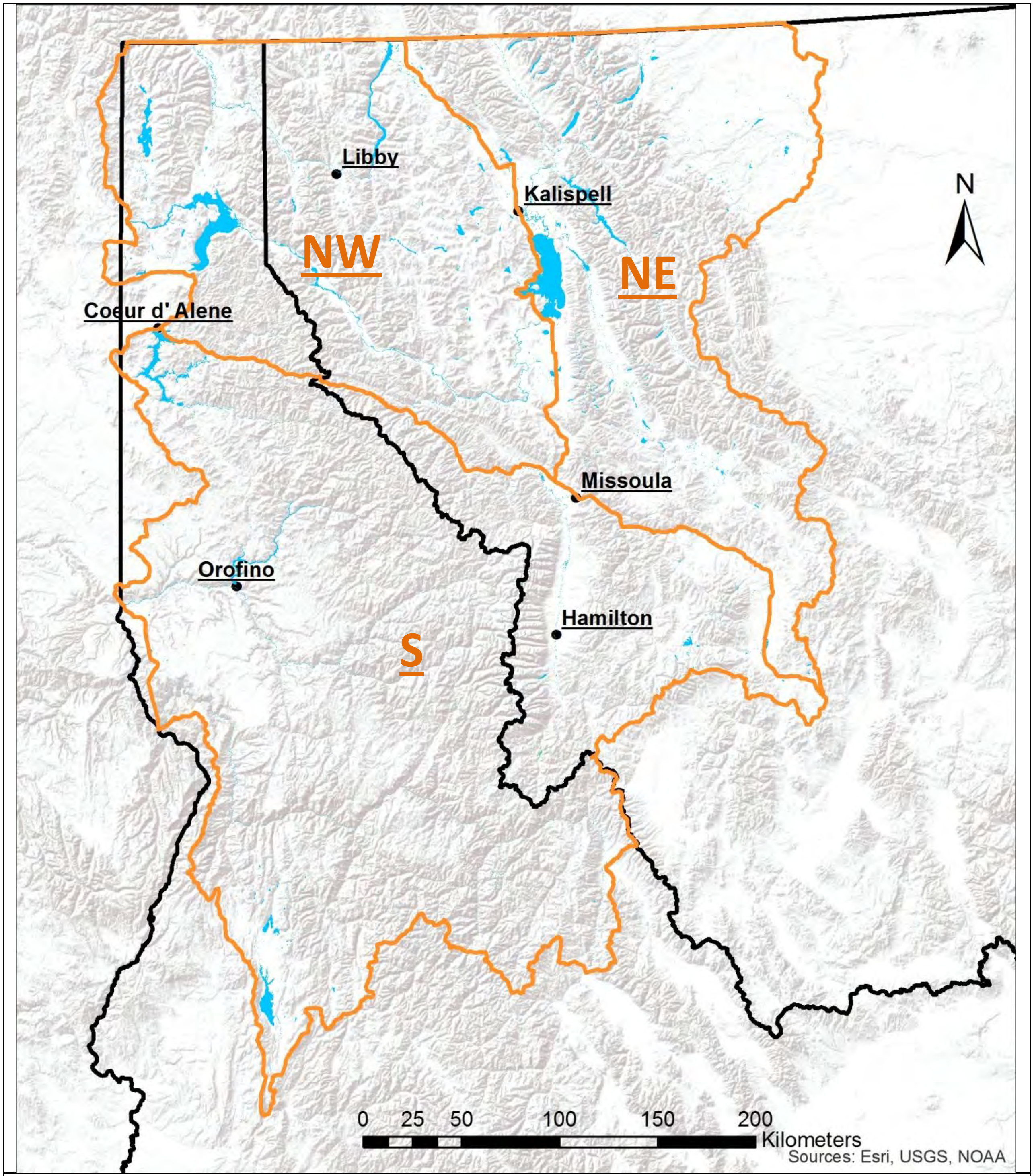


Figure 5. Fisher spatial unit boundaries in the northern rocky mountains. Spatial units names are NW = Northwest, NE = Northeast, and S = South. The outer boundary is the study area from Olson et al. 2014.

3.3 Species Distribution Models

Species distribution models use known locations of individual animals within particular areas to determine the physical and environmental variables associated with those occurrences. These associations are then used to model or predict habitat for that species across a wider area (Olson et al. 2014, p. 90). Two recent species distribution modeling efforts for fisher have been conducted in the NRM: Olson et al. 2014 and Sauder 2014. Olson developed one model based on climate and topographic variables (Olson climate model) and one based on both climate/topography and vegetative variables (Olson full model) to predict fisher habitat in the NRM. Sauder combined Olson's climate model with several other vegetative-based models to produce a model (Sauder model) similar to the Olson full model. All three models (Olson climate, Olson full, and Sauder) provide relatively similar projections of modelled fisher habitat in the NRM (Figure 6; Table 3).

Table 3. Area of modelled fisher habitat in the northern rocky mountains from three recent modelling efforts.

Model	Area (km^2)
Olson climate	30,746
Olson full	36,484
Sauder	35,667*

*Sauder characterized fisher habitat as "probable" and "high quality". The area reported here is the sum of the "probable" and "high quality" areas because this combination of areas was most similar to Olson's methodology and therefore more accurate for comparison purposes.

The primary variables in the Olson climate model contributing to the prediction of modelled fisher habitat in the NRM were mean annual precipitation, topographic position index, and mean temperature of the coldest month (Olson et al. 2014, p. 93). Generally, the probability of modelled fisher habitat in the NRM increased with greater mean annual precipitation, negative topographic index (presence of drainages), and mid-values of mean temperature in the coldest month (Olson et al. 2014, p. 93). As figure 6 depicts, all three models produce very similar modeling results of projected fisher habitat. We conclude that, even though the Olson climate model does not contain vegetative variables within the model itself, it projects very similar results as the Olson full model and Sauder model (which do contain vegetative variables) because the Olson climate model predicts climatic conditions capable of supporting the landscape vegetative characteristics (e.g., 25 – 50 m canopy height, montane riparian vegetation, intermediate abundance of high canopy cover, intermediate landscape edge density, large patches of mature forest in close proximity, and percentage of landscape classified as open area) that are contained as variables within the Olson full and Sauder models.

We utilized the Olson climate model for assessing both current and future condition of fisher habitat in the NRM for multiple reasons. While both the Olson full model and Sauder model are likely better predictors of current probable fisher habitat because they incorporate vegetation variables, the Olson climate model exhibits substantial overlap (agrees well) with both those models. In addition, Olson recently switched base vegetation layers in their full model to include some finer scale data (GAP data); comparisons of overlap with the Olson climate model were similar to that with the coarser data, indicating robustness of the Olson climate model with different settings (Olson 2017b, pers. comm.). Lastly, the Olson climate model allows us to make comparisons between current and future conditions of fisher habitat in the NRM (Olson et al. 2014, entire); a necessary prerequisite in the SSA framework. However, the Olson climate model has the following limitations: 1) the model only predicts climate conditions necessary to support fisher habitat, not specific vegetative conditions, 2) the model does not account for any lag time between having suitable climate conditions and having suitable fisher habitat (e.g., large trees, mature forest), 3) the model is based on one climate projection (i.e., a forecast of future climate conditions) and as such does not represent the full range of potential climate futures for the NRM. We are mindful of these limitations and discuss them in relation to any results generated from the model in later sections of the report. For more information on model and analysis assumptions, see Appendix A.

The amount of modelled habitat predicted by a species distribution model is based on choosing a threshold value that delineates habitat from non-habitat. The choice of a threshold value is important because different threshold values can substantially alter the amount and distribution of modelled habitat. In this case, we adopted the threshold value chosen in Olsen et al. 2014 to delineate potential habitat from non-habitat. This threshold value maximized the sum of sensitivity and specificity (Jimenez-Valverde and Lobo 2007 *and* Freeman and Moisen 2008 *in* Olsen et al. 2014, p. 92), which essentially gives equal importance to correctly predicting fisher presence and correctly predicting fisher absence in the habitat model (Sauder 2017, p. 1). Using this approach, the Olson climate model estimates 30,746 km^2 of modelled fisher habitat in the NRM (Figure 7; Table 3). It is important to note Olson observed little difference in modelled habitat when including and excluding occurrences of introduced Midwest fisher (Olson et al. 2014, p. 93), thus occurrences from Midwest fisher were incorporated into the final model. Also important to note is that modelled fisher habitat depicted by the Olsen climate model represents first order habitat selection at the distribution scale and is a relatively coarse characterization of modeled fisher habitat. However, given the lack of more resolute habitat predictions and that the Olson climate model agrees well with similar models containing vegetative variables (including one recent effort using finer scale vegetative layers), we find the Olson climate model and its predictions of modeled fisher habitat to be a reasonable and appropriate way to explore relationships between the amount and distribution of potential fisher habitat in the NRM.

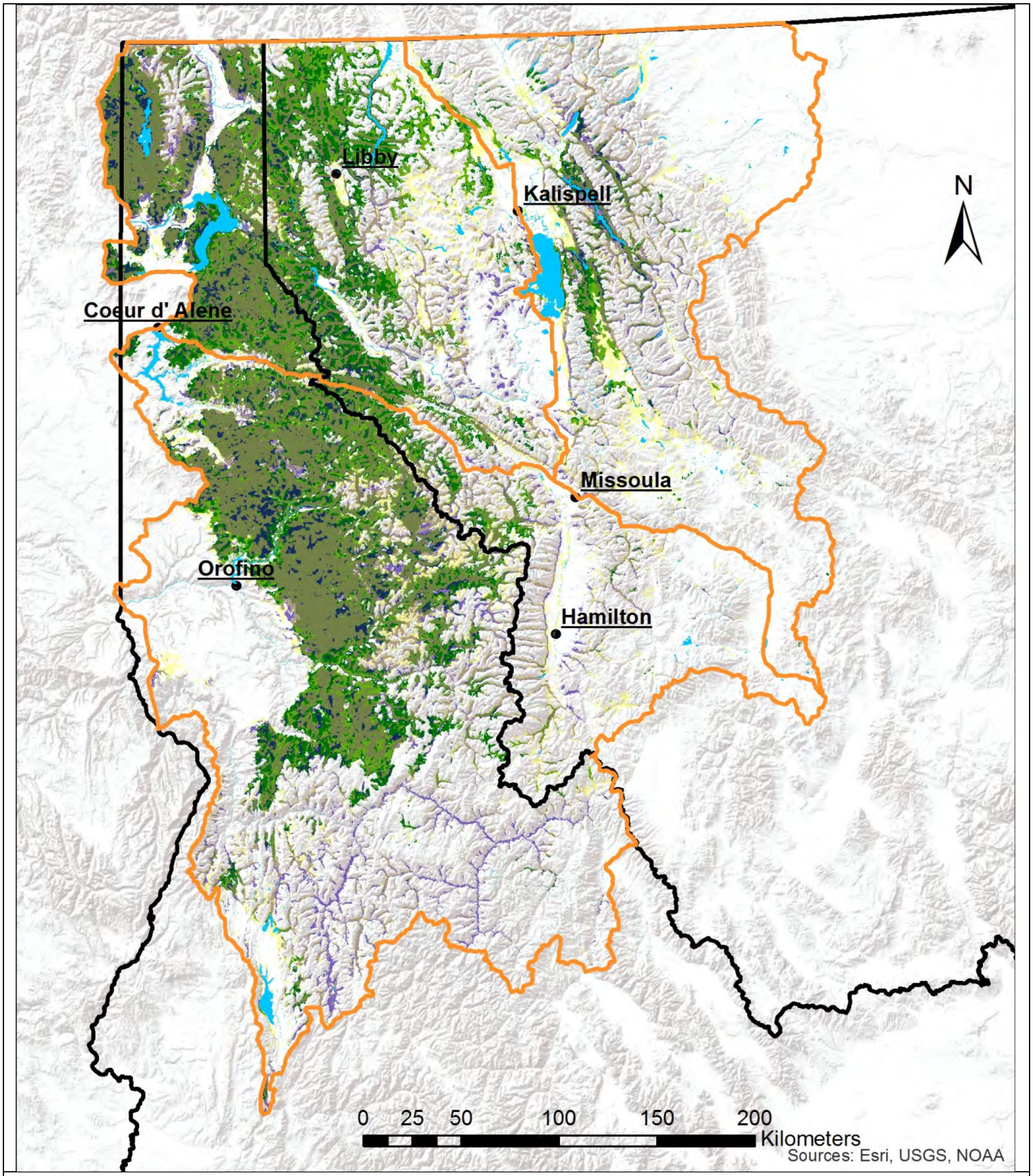


Figure 6. Overlay of modelled potential habitat for fisher in the NRM using the Olson climate model, Olson full model and the Sauder model. Grey shading represents the area of modelled fisher habitat predicted by all three models.

3.4 Needs of the NRM Fisher

Individual needs

To explore the needs of individual fishers in the NRM, we calculated the number of male home ranges (approximately 100 km^2) that could hypothetically fit into the polygons of potential fisher habitat predicted by the Olson climate model. To count in this analysis, a habitat patch had to be at least 100 km^2 of contiguous, modelled habitat. The hypothetical number of male home ranges predicted to fit within the area of modelled fisher habitat varied from 17 to 128 among fisher spatial units and total 238 patches across the NRM (Table 4). This analysis is intended to be a representation of how many potential male home ranges there may be in the NRM. It is highly unlikely that all modelled habitat is occupied by fisher (IDFG 2017a, p. 7), thus indicating a potential positive bias in this analysis. Conversely, fishers have been observed in marginal or unmodelled habitat [(e.g., parts of some industrial forests; IDFG 2017a, p. 7)], likely occupy home ranges that have some proportion of unsuitable habitat (IDFG 2017b, p. 4), and males exhibit some home range overlap (~10%; Sauder 2017, pers. comm.). These factors could potentially negatively bias this analysis. However, despite these potential biases, this analysis represents a reasonable way to explore the relationship between average size of a male fisher home range and the amount of modelled fisher habitat in the NRM and has been used by other fisher researchers when abundance data are limited or lacking (Lofroth 2004, pp. 19-20).

In the NRM, habitat patches of approximately 100 km^2 (the average size of a male home range) can hypothetically support multiple fishers; 1 male, 2-2.5 females, several juveniles and a sub-adult (Sauder in Inman 2016, pers. comm.). These densities should be viewed as rough estimates and not absolute values (IDFG 2017a, p. 7) because representative, rangewide density information from the NRM is lacking. Based on the potential number of male home ranges in the NRM using the Olson climate model, we calculated a range of potential fisher capacity for each spatial unit (Table 4). The potential fisher capacity is a theoretical number of fisher that could inhabit the number of contiguous habitat patches of 100 km^2 in the NRM. The potential fisher capacity is not a population estimate, but rather a coarse estimation of the potential carrying capacity in the NRM, and should be viewed as such until more refined data are available. For the purposes of this analysis, we calculated potential fisher capacity based on 1 male, 2 females, and 2 juveniles per 100 km^2 (Sauder *in* Inman 2016, pers. comm.).

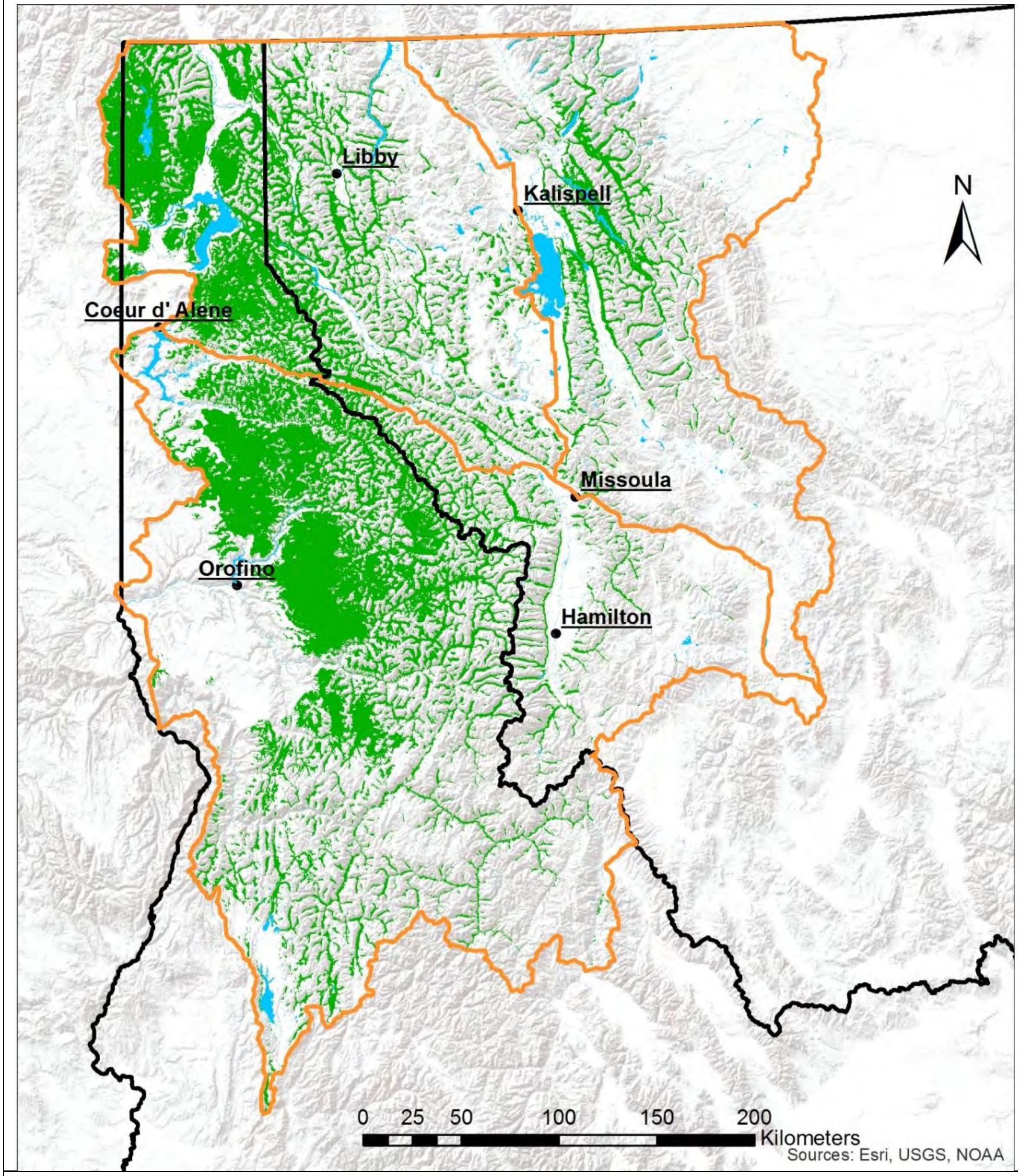


Figure 7. Current extent of modelled fisher habitat within fisher spatial units in the northern rocky mountains depicted by the Olson climate model, 2014.

Table 4. Number of contiguous modeled habitat patches ($100km^2$ and $2,500km^2$) and number of potential fishers for current modeled habitat predicted by the Olson climate model, by fisher spatial unit.

	Spatial Unit			
Contiguous habitat patches ≥	NW	NE	S	Totals
$100\ km^2$	93	17	128	238
$2500\ km^2$	3.3	0.6[a]	4.3	8.2
Potential fisher capacity	465	85	640	1190

[a] Only values greater than 0.5 are reported for contiguous habitat patches ≥ $2500\ km^2$.

Population Needs

Patch Size

A second measure of patch size that addresses the need to support long term persistence of a population or species is a Minimum Critical Area (MCA; Allen et al. 2001, p. 136). A MCA is defined as the median home range size of the species multiplied by 50 (to account for 50 breeding individuals) and divided by 2 (to account for overlap between sexes in home ranges). We calculated an MCA for fisher in the NRM to be $2500\ km^2$, based on a median $100\ km^2$ home range for male fisher, and assuming one male and one female within that home range. We assumed one male and one female fisher within a $100\ km^2$ home range to account for some of the uncertainty in actual occupancy rates of fishers in the NRM. The MCA method may be negatively or positively biased for fishers depending on the area and habitat quality, but represents a reasonable approach and metric to explore how contiguous existing modeled fisher habitat is. The number of MCA's in the modeled habitat from the Olson climate model varies from 0 to 4 among spatial units and total 7 for the NRM (Table 4).

Connectivity

Fisher populations need connectivity among habitat patches, namely for dispersal of young, finding mates, and occupying adjacent areas of suitable habitat (Sauder and Rachlow 2014, p. 82; Jones and Garton 1994, pp. 380, 385-386). Canopy cover is important in influencing fisher movement and connectivity between habitats, as fisher typically avoid open areas (Sauder and Rachlow 2014, p. 80). In the NRM, connectivity along the north-south axis appears high, given the large, contiguous patches of modeled habitat predicted by the Olson climate model (Figure 8). In addition, most modelled potential habitat is on Federal land with substantial canopy cover (Figure 8; USDA 2008, unpublished data). However, connectivity along the east-west axis appears lower, due to the presence of several broad, glaciated valleys situated along the north-south axis (Figure 8). Landcover in these valleys is typically shrubs, grasslands or agricultural fields, along with rural infrastructure, including towns, subdivisions, and small ranchettes. While we are unsure of how much these landcovers and the associated lack of canopy cover may reduce fisher movement in the east-west direction, we have identified four areas of potential connectivity in the east-west direction that fisher may use, based on current canopy cover greater than 40 percent (Jones 1991, p. 90; Figure 8). We are unaware of any empirical data showing fisher currently using the three potential east-west linkages in Montana. However, genetic sampling has suggested that fishers may be using the potential east-west linkage identified between the Cabinet and Selkirk mountains in Idaho (IDFG 2017b, p. 2).

Although habitat conditions that provide overhead cover (e.g., dense forests) appear to facilitate fisher movements and population connectivity, fisher are capable of traversing landscapes that appear to contain significant barriers to their movements. For example, five fisher have recently been detected moving from a naturally occurring population in the Siskiyou Mountains in southern Oregon to an introduced population in the southern Cascade Range (Pilgrim and Schwartz 2016, unpublished report). These two mountain ranges/fisher populations are separated by approximately 50 km containing broad valley bottoms with significant human development (cities, towns, farms, highways, and Interstate 5). Thus, while these impediments most likely reduce connectivity between these two fisher populations, individual fisher are able to move across this landscape, albeit at a potentially reduced level.

3.5 Potential Stressors

Climate change

The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). The term “climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2014, pp. 119–120). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2014, p. 120).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring; since the 1950s many of the observed changes are unprecedented over decades to millennia (IPCC 2014, p. 40). Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions. (For these and other examples, see IPCC 2014, pp. 40–44; and Solomon *et al*. 2007, pp. 35–54, 82–85). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is “extremely likely” (defined by the IPCC as 95 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2014, p. 48 and figures 1.9 and 1.10; Solomon *et al*. 2007, pp. 21–35).

Olson et al. (2014) modelled fisher habitat using a suite of climate variables. Variables with the greatest contribution to predicting modeled fisher habitat were mean annual precipitation, topographic position index, and mean temperature of the coldest month (Olson et al. 2014, p. 93). Generally, the probability of potential fisher habitat in the NRM increased with greater mean annual precipitation, negative topographic index (presence of drainages), and mid-values of mean temperature in the coldest month (Olson et al. 2014, p. 93). These important climatic variables support the vegetative components (e.g., large trees, canopy cover) that fisher select for in the NRM.

Individual and Population Effects

The historical effects of climate have contributed to the current amount and distribution of modeled fisher habitat in the NRM. However, it is unknown how much the historical rate of climate change has influenced these metrics. Climate change could potentially affect fisher habitat by altering the structure and tree species composition of forests within the NRM and also through changes to the habitat of prey communities. Some of these effects could be negative, such as loss of rest and den structures for individual fisher resulting in decreased reproductive rates, altered behavioral patterns, or displacement. Some effects could be positive, such as increased abundance of prey in response to vegetation changes or reduced snowpack. Any alterations from climate change that increased connectivity among modelled habitat patches or increased modelled habitat patch size would be expected to have positive effects on the NRM fisher population.

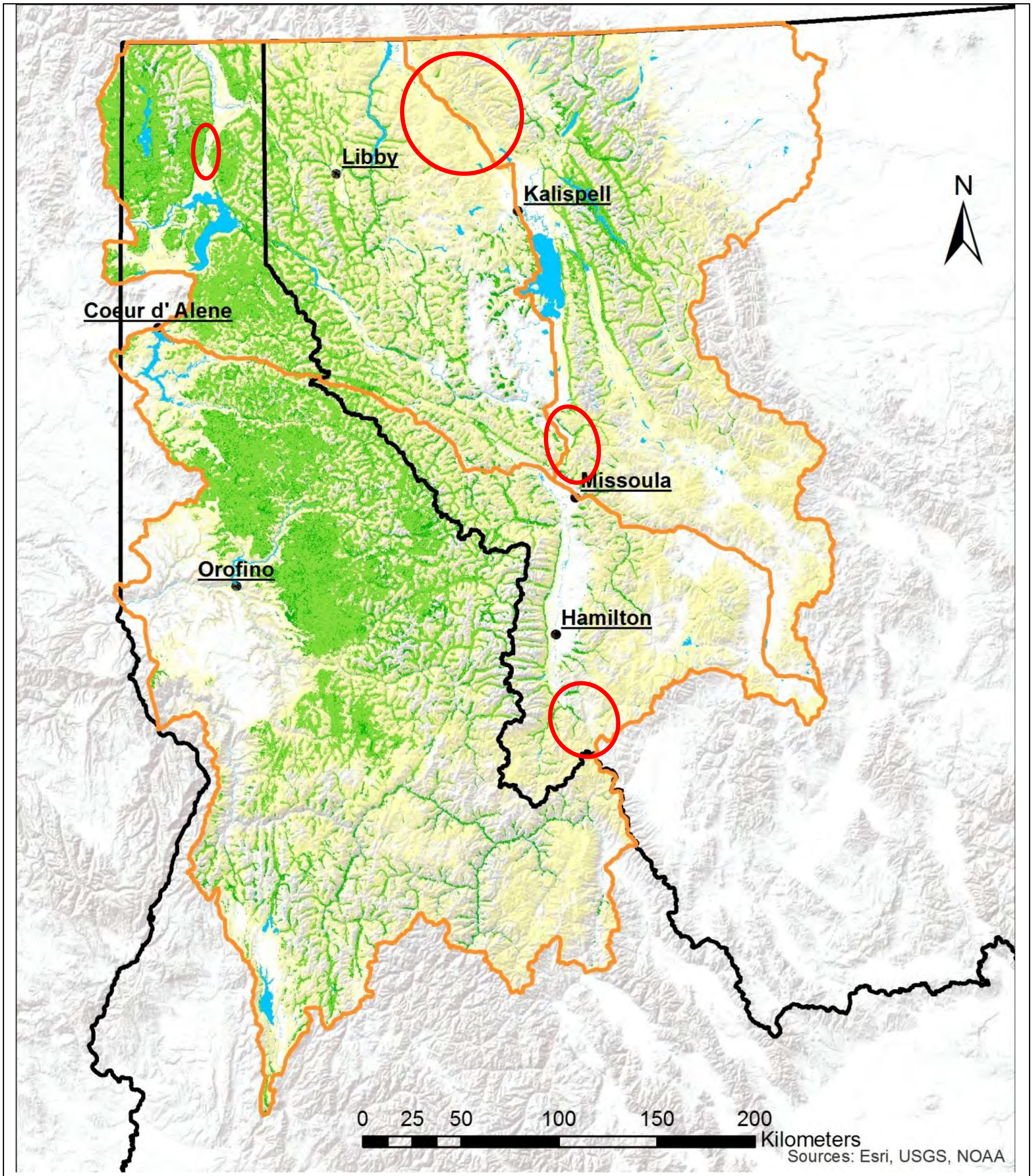


Figure 8. Current estimated modeled fisher habitat (green; Olson climate model) overlaid by canopy cover greater than or equal to 40 percent (yellow; USDA 2008, unpublished) in the NRM. Red ovals depict potential connectivity corridors for fisher movement along the east-west axis in the NRM.

Development/Roads

The amount and distribution of human development in the NRM is varied. In general, higher intensity human development in the NRM occurs in open, glaciated valley bottoms, which are primarily owned privately or by municipalities, and support towns, housing developments, agricultural crops and extensive road networks. As elevation increases upslope from the valley bottoms, lands typically transition to Federal ownership and the level of human development is substantially reduced (Figure 9). However, some development has occurred at the wildland urban interface in forested valley bottoms and riparian areas that likely overlap with fisher habitat (Carroll *et al.* 2001, p. 962).

Individual Effects

Human development in areas of suitable fisher habitat could have potential negative effects on individual fisher. First, the effects of human activity and infrastructure may cause fisher to avoid these areas. Second, the physical footprint of development could directly replace suitable habitat for fisher, thereby reducing the total amount of habitat and displacing individual fisher. Third, increased networks of roads can increase incidence of direct mortality from vehicle collisions (Ruediger 1994, p. 3; Carroll *et al.* 2001, p. 969; Brown *et al.* 2008, p. 23).

Population Effects

Patch Size

Human development could have negative effects on patch size of suitable fisher habitat. Development could decrease habitat patch sizes for fisher and result in fewer patches of habitat. Decreased patch sizes could reduce habitat below the thresholds needed for fisher to establish home ranges. Fewer habitat patches could result in fewer reproductive units of fisher in the NRM or fewer reproductive individuals within a reproductive unit.

Connectivity

Primary and secondary highways bisect modelled fisher habitat in multiple places in the NRM (Figure 9), potentially fragmenting habitat and resulting in reduced connectivity between habitat patches. Fragmentation and reduced connectivity could result in reduced gene flow across the NRM and negatively affect the ability of fishers to utilize more suitable habitats following a stochastic or catastrophic event.

Related Effects to Current Condition

Despite the potential for development in the NRM to negatively affect both individual fisher and the population as a whole, evidence of such effects is lacking. For example, fisher did not avoid areas adjacent to a State highway that traverses National Forest land in Idaho (Schwartz *et al.* 2007, p. 6), and fisher have been detected in the vicinity of roads during other targeted survey efforts in northern Idaho (Schwartz *et al.* 2007, p. 6; Albrecht and Heusser 2009, p. 8). In addition, road density was not a significant variable in describing suitable fisher habitat in the NRM (Sauder and Rachlow 2014, pp. 78-79). The amount of overlap between human development and modelled fisher habitat is unquantified, but small compared to the total amount of modelled fisher habitat in the NRM. Thus the total amount of true habitat loss caused by this overlap appears to be minimal and constrained by the fact that most suitable habitat is on Federal land, where housing development potential is negligible. Lastly, we are only aware of one incidence of a vehicle striking a fisher in Idaho (NRMFID 2017, p. 222). Thus, the effects of human development on habitat for individual fisher in the NRM appear low. Fisher movement and habitat connectivity in the NRM appear to be more influenced by canopy cover, with many of the roads and highways representing very small, linear openings in otherwise contiguously canopy-covered areas (Figure 9).

Forestry practices

Vegetation management includes a wide assortment of timber harvest and other forest stand treatments that can affect the ability of the forest vegetation to provide fisher habitat, both positively and negatively. Fishers occur in landscapes where active vegetation management occurs (Sauder and Rachlow 2014, entire), but our understanding of the effects of these activities on fishers and their populations is limited and results can vary with type, intensity, duration, and seasonality of treatment; scale of treatment; and the activity for which the fishers use a specific area (for example, denning vs. foraging; Sweitzer et al. 2016, entire). There is no analysis that explicitly tracks changes in fisher habitat in recent decades where loss to vegetation management specifically can be determined. Thus, we do not have the capability to assess vegetation management by assessing the specific vegetation management activities that may act as a stressor to fishers.

In general, timber harvest and management over the last century have resulted in the loss of old forest and large- and medium-diameter trees that historically were widely distributed in forest structures other than old growth forest (Hessburg and Agee 2003, p. 45). Fragmentation of managed landscapes has increased due to more numerous and smaller patches of various forest types, while roadless and wilderness areas have retained a simpler, less fragmented structure (Hessburg *et al.* 2000, p. 78). However, the current amount of land covered by forest in the NRM is similar to that of historical times (Hessburg *et al.* 2000, p. 60). From a landscape perspective, the departure from historical mature forest structure is most pronounced in the northern areas of the NRM, with a concurrent shift to increasing old-forest multistory stages in the southern areas (Wisdom *et al.* 2001, p. 184).

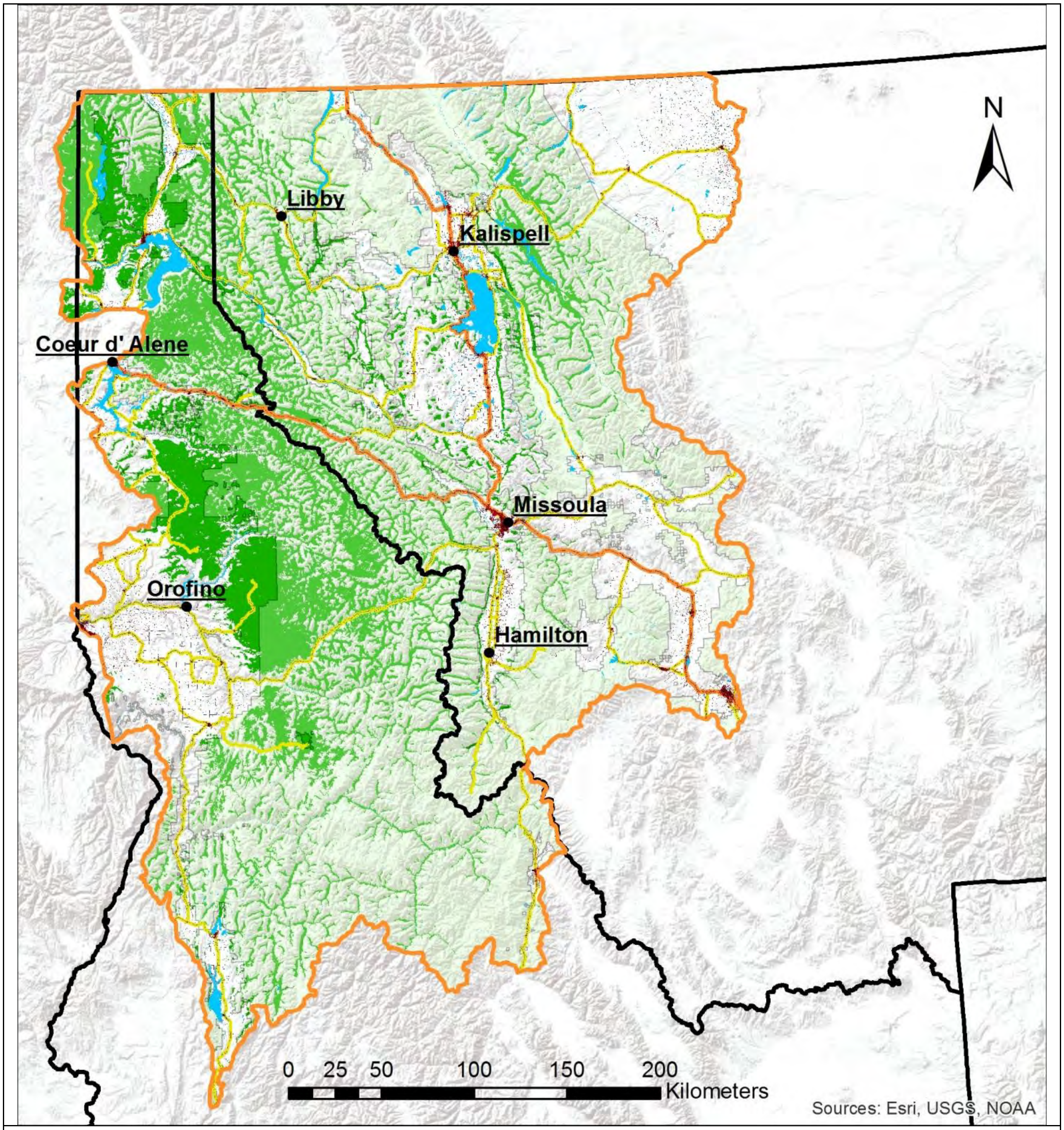


Figure 9. Amount and distribution of human development in the NRM, by fisher spatial unit. Yellow lines depict primary and secondary highways (United States Census Bureau 2016). Burgundy dots depict areas of human development (USDA 2008). Green shading depicts potential fisher habitat modelled by the Olson climate model, with light green shading depicting an overlay of Federal land ownership (ESRI 2017).

Individual Effects

Timber harvest and management have significant potential to alter the suitability of a landscape for individual fisher. The loss or reduction of canopy cover and large trees following timber harvest are two primary habitat effects that could affect individual fisher. Fisher need large trees for resting and denning (Schwartz et al. 2013, p. 108; Raley et al. 2012, p. 243, 251) and establish home ranges that minimize open areas (Sauder and Rachlow 2014, p. 81). Timber harvests that affect these two variables could result in displacing individual fisher or result in fisher not using parts of former home ranges. However, it is unclear if either of these scenarios may ultimately affect individual fisher survival, reproduction, foraging and other life history attributes.

Conversely, timber harvest and management of forests may mimic natural disturbances (Powell and Zielinski 1994, p. 64) and assist in creating conditions that fisher select for in the NRM (larger trees; Schwartz et al. 2013, 107; habitat edges; Sauder and Rachlow 2015, pp. 52-53; snags; Schwartz et al. 2013, p. 107; heterogeneous habitat; Sauder and Rachlow 2015, pp. 52-53). Fishers in the NRM evolved in forest types where fire frequency and intensity was mixed, and windthrow was common, resulting in a complex and intricate landscape mosaic of young, mixed-age, and late-seral components (Jones 1991, p. 111; Arno *et al.* 2000, pp. 225–227), thus they appear to have some tolerance for disturbance (Zielinski et al. 2013, pp. 824-825). However, the degree to which forestry practices mimic natural disturbance and the magnitude of beneficial effect for fishers is not well understood.

Population Effects

Patch Size

Timber harvest could eliminate or at least reduce the size of suitable habitat patches for fishers, resulting in reducing the number of fisher home ranges or MCAs on the landscape.

Connectivity

Loss of canopy cover due to timber harvest could fragment suitable habitat and decrease connectivity among suitable habitat patches. This could limit fisher movement and reduce gene flow across the NRM.

Related Effects to Current Condition

In the NRM, most documented fisher occurrences are on Federal land. Federal land in the NRM is primarily managed by the United States Forest Service under a multiple use management regime (National Forest Management Act 1976). Timber harvest is one such multiple use activity that is conducted on Forest Service land. Despite the potential negative effects of timber harvest on individual fisher and the population as a whole, fisher in the NRM are selecting for landscapes that are currently managed for multiple use (Sauder and Rachlow

2014, pp. 80-81). It is likely that timber harvest in the NRM has supplemented natural disturbance regimes (fire, windthrow, etc.) that historically provided heterogeneity across the landscape, to some degree. Similar to fire or other disturbances, the negative effects of timber harvest are temporary. For example, in some parts of the NRM, the reemergence of canopy cover in clearcuts to greater than 10% is expected to take about 10 years (Staab 2017, pers. comm.). The 10% canopy cover level is important because at this level fisher would be expected to use these areas (Sauder and Rachlow 2014, pp. 78, 80). Thus, currently it appears the negative effects of current timber harvest practices on fisher are temporary and low.

Fire

Fire disturbance was an integral force in shaping the NRM forest ecosystem well before European settlement of the region (Lesica 1996, p. 33) and recurred throughout the region at varying intervals. Mean fire return interval is the average period of time between fires in a given area or habitat type. Mean fire return interval is influenced by climatic conditions, in part (Higuera et al. 2015, p. 10), and directly influences the amount and distribution of vegetation in the NRM.

Currently, modelled fisher habitat in the NRM is best characterized by three mean fire return intervals; 21-25 years for the patchier, lower elevation habitat, 71-80 years for the more contiguous mid-elevation habitat, and 150-200 years for the patchier, high elevation habitat (Figure 10; USDA 2008, unpublished data). Longer fire return intervals, like those for the mid-elevation and high elevation habitat are likely a result of the wetter, maritime climate and topography in the NRM. Riparian areas and topographic drainages that retain more moisture than surrounding uplands support the large trees and habitat complexity needed by fisher to establish home ranges. These climatic conditions and longer fire return intervals have allowed for mature trees to persist in the NRM. Because of longer fire return intervals, smaller, local fires likely have a low effect on the amount and distribution of vegetation in the NRM.

Extensive regional fires events also occurred in warm and dry summers preceded by warm springs in the NRM, although less often than small local fires (Morgan *et al.* 2008, p. 723). One of the largest regional fires of the 20th century occurred in 1910, consuming over 11,675 km^2 (4507 mi^2) in northern Idaho and scattered locations in northwest Montana (Figure 11; Morgan *et al.* 2008, p. 721). These larger, regional fires dramatically changed the landscape over very short periods of time and likely had a more pronounced effect on historic fisher habitat than did the smaller, local fires.

Individual Effects

Catastrophic fires like the 1910 fire likely altered fisher habitat by burning large mature trees and reducing canopy cover that individual fisher need for resting and denning sites, reducing proximity of mature forest patches and riparian vegetation. Fires of this magnitude and extent likely displace individual fisher and may directly kill individuals unable to escape fire perimeters.

Population/Species Effects

Patch size

Large regional fires can eliminate entire patches of suitable habitats or at least reduce the size of suitable habitat patches for fisher, resulting in reducing the number of fisher on the landscape.

Connectivity

Loss of canopy cover due to fire could fragment suitable habitat and decrease connectivity among suitable habitat patches. This could limit fisher movement and reduce gene flow across the NRM or decrease the ability of fisher to relocate to more suitable habitats following a catastrophic fire.

Related Effects to Current Condition

Fisher have evolved in the fire-disturbed NRM for about 4000 years. While fire can reduce suitable habitat for fisher, those effects are temporary, albeit at varying time scales. Fisher in the Sierra-Nevada range in California were detected using mixed-severity fire landscapes 3-4 years post-fire (Hanson 2013 in Hanson 2015, p. 499) and female fisher used high severity fire areas just as much as adjacent unburned areas 10-11 years post-fire (Hanson 2015, p. 499). Similar to timber harvest, wildfire may temporarily displace fisher and reduce suitable habitat. However, fire can create edge habitats, and a complex mosaic vegetation pattern that fisher utilize in the NRM. Currently, potential fisher habitat in the NRM is fairly contiguous with a high degree of canopy cover between habitat patches. These attributes are expected to aid fisher in dispersing to other areas in the event of a catastrophic fire. In addition, we expect fisher to use burned areas in the NRM, similar to in the Sierra Nevada range. Thus currently, it appears that the effects of fire on fisher in the NRM are low.

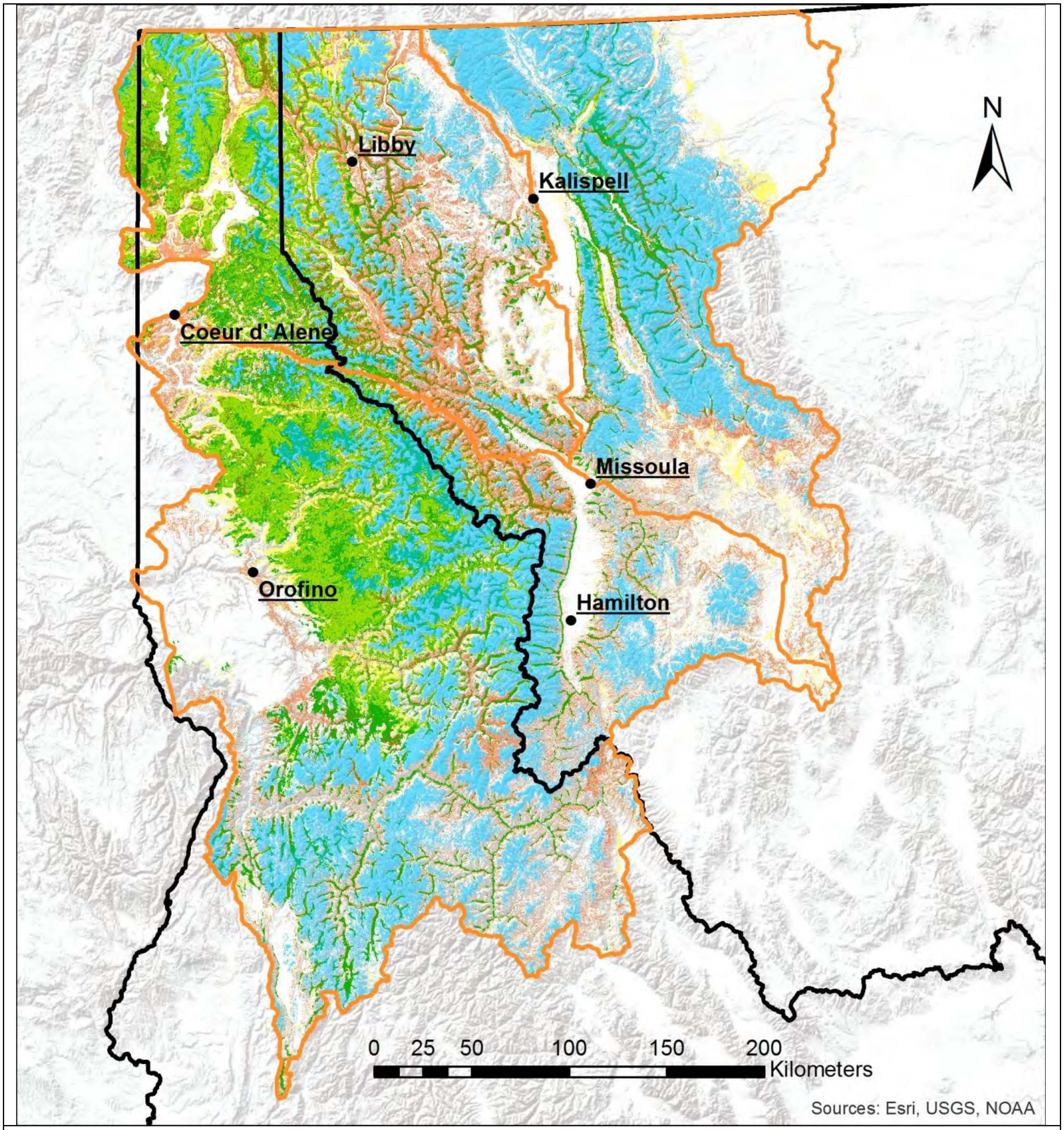


Figure 10. Mean fire return intervals for modelled suitable fisher habitat in the northern rocky mountains (USDA 2008). Red shading depicts a 21-25 year return interval, yellow shading depicts a 71-80 year return interval, and blue shading depicts a 150-200 year fire return interval. All fire return intervals are overlaid on current suitable fisher habitat modelled by the Olson climate model, depicted in green.

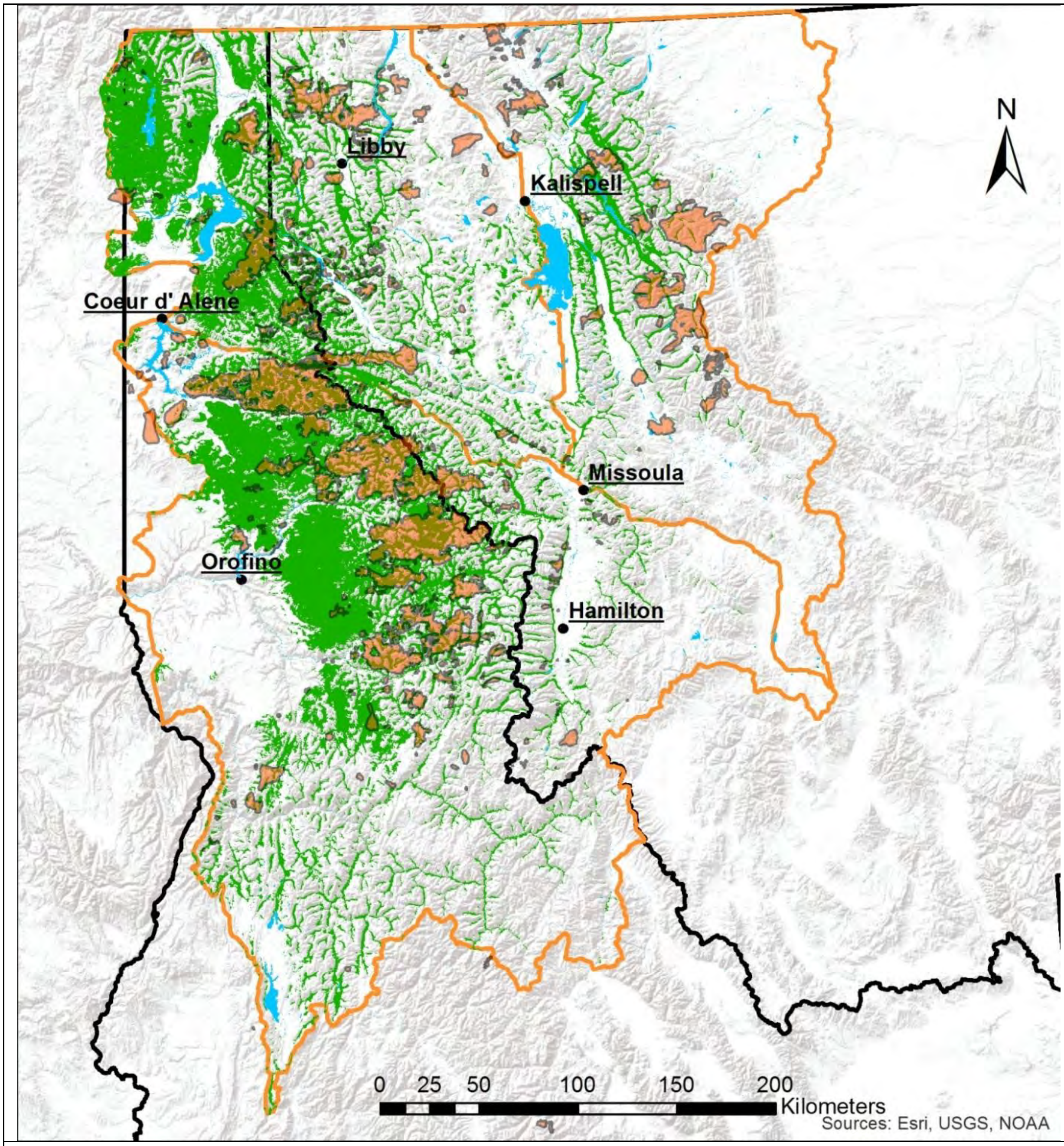


Figure 11. Fire perimeters of the 1910 fires overlaying modelled suitable habitat for fisher in the northern rocky mountains (USDA 2008).

Trapping

In the late 1800s and early 1900s, heavy trapping pressure on fishers resulted from the high value of pelts, the ease of trapping fisher (Powell 1993, pp. 19 and 77), year-round accessibility in the low- to mid-elevation coniferous forests where they live, and the lack of trapping regulations (Aubry and Lewis 2003, p. 89). Such unregulated overharvest, and the unregulated use of strychnine as a trapping and general predator control agent, in addition to some potential habitat loss, likely eliminated or greatly reduced fisher numbers across their range by the mid-1900s (Douglas and Strickland 1987, p. 512; Powell 1993, p. 77). Other contributing factors in the decline were likely that fisher are easily trapped (Douglas and Strickland 1987, p. 523) and have a slow reproductive rate (Powell and Zielinski 1994, p. 64).

In the NRM, trapping of fishers can be targeted or incidental. Montana currently allows targeted trapping for fishers while Idaho does not. Targeted trapping is where trappers specifically target fishers, while incidental trapping is where trappers incidentally capture fishers in traps targeting other furbearers (e.g., pine marten, bobcat, etc.). Thus, the number of fishers trapped in the NRM annually is the total of targeted and incidental captures from Montana plus the incidental captures from Idaho (Table 5).

Targeted trapping for fisher is currently allowed in Montana in two trapping districts; the Bitterroot and Cabinet Fisher Management Units. There is an annual quota of 5 fishers (with a 1 female subquota) in the Bitterroot Unit and 1 fisher in the Cabinet Unit (MFWP 2017, pp. 14-17). The subquota for one female fisher in the Bitterroot Unit means that once a female fisher is trapped in that Unit, fisher trapping is closed in that Unit for the rest of the season, regardless of whether the overall quota was reached or not (MFWP 2017, p. 17).

Individual Effects

The effects of trapping on individual fishers span a spectrum from negligible injuries to death, with the extent of injury likely varying by trap type, trap set, anatomical position of trap, duration of animal in trap and myriad other variables. Injuries to fishers that either escaped traps or were incidental captures that were released alive could affect the ability of that fisher to carry out many life functions, including foraging, mating, or escaping predation. Fisher mortalities from trapping would directly reduce the number of individual fisher in a population.

Table 5. Trapping captures of fishers in Idaho (incidental) and Montana (incidental and targeted) between 2002–2016. Status of animal (e.g., dead, released alive) apply only to Idaho captures.

	Idaho			Montana	Montana and Idaho Subtotals	
Year	Dead	Released alive or unknown	Subtotal	Incidental and targeted	MT and ID (dead only)	MT and ID (all)
2002–2003	2	3	5	9	11	14
2003–2004	0	5	5	9	9	14
2004–2005	1	9	10	8	9	18
2005–2006	2	9	11	11	13	22
2006–2007	0	16	16	7	7	23
2007–2008	3	11	14	7	10	21
2008–2009	2	16	18	7	9	25
2009–2010	8	30	38	8	16	46
2010–2011	4	42	46	5	9	51
2011–2012	18	12	30	6	24	36
2012–2013	12	35	47	8	20	55
2013–2014	27	31	58	5	32	63
2014–2015	3	12	15	6	9	21
2015–2016	4	12	16	4	8	20
Totals	86	243	329	100	186	429

Population Effects

It appears that trapping effort is not uniform across the NRM and is more concentrated closer to accessible areas and roads (NRMFID 2017, pp. 9, 222). Given this information, areas with clustered trapping effort may create populations sinks. Population sinks are areas where death rates exceed recruitment rates and there are no excess individuals to immigrate to adjoining habitat (Schreiber and Kelton 2005, pp. 995-996). The existence of population sinks could limit gene flow across the NRM by limiting fisher movement through some areas or reducing reproductive capacity among fishers.

Trapping could also affect the population growth rate of fisher in the NRM. Overharvesting adult females in particular could substantially affect the population growth rate of NRM fishers (Buskirk et al. 2012, entire).

Related Effects to Current Condition

We used data from Table 5 to develop three current trapping scenarios and estimate their respective effects on the current fisher potential capacity in the NRM. The three trapping scenarios are:

1) The average annual number of trapped fisher in Montana and Idaho (status = dead only) from 2002 – 2016; **value = 13**
2) The average annual number of trapped fisher per year in Montana and Idaho (all fisher regardless of status) from 2002 – 2016; **value = 31**

3) The maximum number of trapped fisher in Montana and Idaho in any given year; **value = 63**.

For this analysis, we calculated the proportion of fisher removed from the potential fisher capacity by dividing the values from each of the trapping scenarios by the total fisher potential capacity from Table 3 (i.e., 1190). We did not have specific locations for all trapped fishers in Idaho, thus we structured our analysis to apply to the entire NRM, not to each individual fisher spatial unit. Our intent was to provide an estimate of the percentage of potential fisher capacity removed by trapping under three different trapping scenarios. These estimates should be revised when abundance is empirically derived for fishers in the NRM. However, this analysis represents a reasonable method to explore the potential effects of trapping on fishers in the NRM, given the lack of abundance data for fishers in the NRM. Our analysis indicates that the proportion of fisher removed from the potential fisher capacity varied from 1.1 to 5.3 percent among trapping scenarios (Table 6).

Table 6. Percentage range of potential fisher capacity trapped in the NRM by trapping scenario.

Time step	Trapping 1	Trapping#2	Trapping 3
Current	1.1	2.6	5.3

Trapping scenario number 2 is expected to be most representative of average trapping effort in the NRM. We do note that scenario number 2 is likely an overestimate of the percentage of potential fisher capacity removed by trapping because some fishers that are incidentally trapped are released alive and probably survive. However, the actual survival rate of trapped fishers that are released alive is unknown (NRMFID, p. 223), thus scenario number 2 assumes all fisher that are trapped are functionally dead, regardless of reported status at release.

Under scenario number 2, the percentage of potential fisher capacity trapped is 2.6 percent. This percentage is low compared to harvest rates from other populations. In south-central Ontario, a harvest rate of 20-25 percent was considered sustainable during the 1979-1989 trapping seasons (Strickland 1994, p. 156). Similarly, a harvest rate of 15-20 percent was considered sustainable in Minnesota (Strickland 1994, p. 157). Lower hypothetical harvest rates of fisher in the NRM relative to populations with established trapping seasons might be expected, given there is no legal trapping season for fisher in Idaho and an annual quota of 7 fishers in Montana.

Conservation measures currently being implemented in Idaho are designed to reduce incidental captures of fishers in traps. Idaho state law requires trappers to release any fishers found alive in traps and submit trapper report cards annually, thus enabling Idaho Fish and Game to track information on incidental captures (IDFG 2017a, p. 3). In addition, state law also mandates trapper education be administered to new trappers by the Idaho Fish and Game Commission and through the mandatory wolf trapper education course (IDFG 2017a, p. 3). The intent of these laws and mandatory courses is to educate trappers on trapping law, ethical trapping, avoiding non-target catch (including fishers), safety, and basic trapping methods.

Recently, population matrix models developed for fisher indicated survival of age 3+ female fishers influence population growth rate more than fecundity (Buskirk et al. 2012, pp. 87-88). Thus, overharvest of adult female fishers from trapping could lead to a population decline in the NRM. In Montana, female harvest is regulated by a subquota which closes the fisher trapping season after the harvest of one female fisher per year (MFWP 2017, p. 17). Thus for Montana, potential for overharvest of female fishers from trapping appears negligible.

Harvest rates of female fisher in Idaho are unknown. However, fisher distribution in Idaho at two different time scales has not changed markedly, despite ongoing incidental capture from trapping (IDFG 2017a, pp. 2, 14, 15). Data comparing fisher distribution from time periods 1978-82 to 2010-16 indicate similar distributions of fisher in Idaho (IDFG 2017a, p. 15). Similarly, fisher distributions from 2004-09 and 2010-15 have not markedly changed (IDFG 2017a, p. 14). However, distributional comparisons over time do not provide any direct information on abundance and are influenced by the amount of sampling effort and type of sampling being conducted and therefore must be interpreted with caution.

Poisoning

We are aware of two types of poisons have been used within the NRM: anticoagulant rodenticides (ARs) and strychnine.

Anticoagulant rodenticides are used to kill small pest mammals by impairing the animal's ability to produce several key blood clotting factors (Berny 2007, p. 97; Roberts and Reigart 2013, pp. 173–174). Anticoagulant rodenticides are legally used primarily by homeowners for pest control. However, illegal use has been documented in areas outside the NRM such as California, to protect illegal marijuana grows from rodents (Gabriel et al. 2012, p. 12).

There are two general types of ARs; first generation and second generation. First generation ARs were introduced in the late 1940s and 1950s and were designed for commensal and field rodent control (Lund 1988, p. 342; Hadler and Buckle 1992, pp. 149–150). They often require multiple feedings to achieve a lethal dose, have a lower ability to accumulate in biological tissue, and have shorter liver elimination half-lives (Fisher *et al.* 2003, pp. 7, 14, 16; Vandenbroucke *et al.* 2008, p. 443; Eason *et al.* 2010, pp. 176–177, 179; Crowell *et al.* 2013, entire). Second generation ARs were developed in the 1970s (for example, Hadler and Shadbolt

1975, p. 275; Hadler and Buckle 1992, pp. 150–151) and are more likely to be acutely toxic and are more persistent in biological tissues than first generation ARs.

Predators such as fisher can be exposed to ARs in two ways. First, fisher could directly eat AR-laced baits intended for rodents. Second, fisher could eat rodents that have already ingested the AR. Because an exposed rodent may live several days after an initial feeding, and can become physically or behaviorally [for example, lethargic, hunched posture Littin *et al.* 2000, pp. 311–312; Swift 1998, pp. 42–44] compromised by the ARs (Cox and Smith 1992, p. 169; Brakes and Smith 2005, p.121), a predator may have a better chance of locating and consuming an AR-exposed rodent over an unexposed rodent (Winters *et al.* 2010, pp. 1075; Vyas *et al.* 2012, p. 2515).

Strychnine is a highly toxic, colorless, bitter, crystalline alkaloid used as a pesticide to primarily kill small animals. Strychnine ingestion affects the central nervous system and results in severe muscle spasms and convulsions leading to asphyxiation through respiratory paralysis, even while the animal's brain and consciousness are unaffected until death. Strychnine does not bioaccumulate in body tissue (Bonar 1995); and it may be consumed at very low dosages over prolonged periods with little or no ill effect (Black 1994, p. 109). Strychnine is generally concentrated in the gastrointestinal tract of targeted animals as it is a fast-acting poison and, therefore, little absorption occurs before the animal succumbs to death (Fagerstone et al. 1980, p.108; Record and Marsh 1988, p. 164). Thus, residues in the gastrointestinal tract of animals poisoned with lethal doses are known to be potentially hazardous if the gastrointestinal tract is consumed (Bonar 1995); and secondary poisoning may occur from ingestion of material stored in gopher cheek pouches (Black 1994, p. 109).

Individual effects

Little is known of the individual impacts of direct or indirect exposure of fishers to ARs, but several inferences can be made. For example, (1) direct consumption of one or more second generation AR has a greater likelihood of resulting in death than secondary consumption, and (2) sublethal exposure to ARs likely results in sickness, which may increase the probability of mortality from other sources. The relationship between AR concentration found in exposed fishers and the rate of mortality or illness is currently unknown. Gabriel *et al.* (2012, p. 11) found that the quantity of ARs observed in fisher liver tissues varied and overlapped extensively in both sublethal and lethal cases with no clear indication of a numeric threshold that might indicate an AR quantity leading to illness or mortality.

Similar to ARs, little is known about the direct or indirect exposure of fisher to strychnine. However, due to the Environmental Protection Agency's labeled treatment methodology requiring placement of strychnine-treated bait (e.g., oats) underground directly into known pocket gopher burrows, there appears little ability for fisher to be directly or indirectly affected. Strychnine-treated bait placed below ground is effective only from 1 week to 1 ½ months (Black 1994, p. 109). Pocket gophers tend to occur in individually occupied burrow systems (Barnes et al. 1985, p. 556), and almost always die underground in their own burrow system when treated with strychnine bait as strychnine is a fast acting poison (Record and Marsh 1988, p. 164; Black 1994, p. 109). According to Schitoskey (1975 *in* Barnes et al. 1985, p. 556), the lowest lethal dose of strychnine recorded for mammals is 0.33 milligrams (mg)/kg, and Black et al (1985, p. 556) found that the average strychnine concentration in gopher carcasses in burrow systems treated with strychnine-treated baits was 0.16 mg. Animals consuming sublethal doses of strychnine-treated bait usually develop an aversion to the bait (Barnes et al. 1985, p.556; Black 1994, p. 37), and some scavengers are apparently able to detect strychnine and avoid the gastrointestinal tract where it is typically concentrated (Record and Marsh 1988, p. 164). Thus, we conclude there is a negligible chance that an individual fisher would locate, excavate, and consume enough gopher cascasses to ingest a lethal dose of strychnine.

Population effects

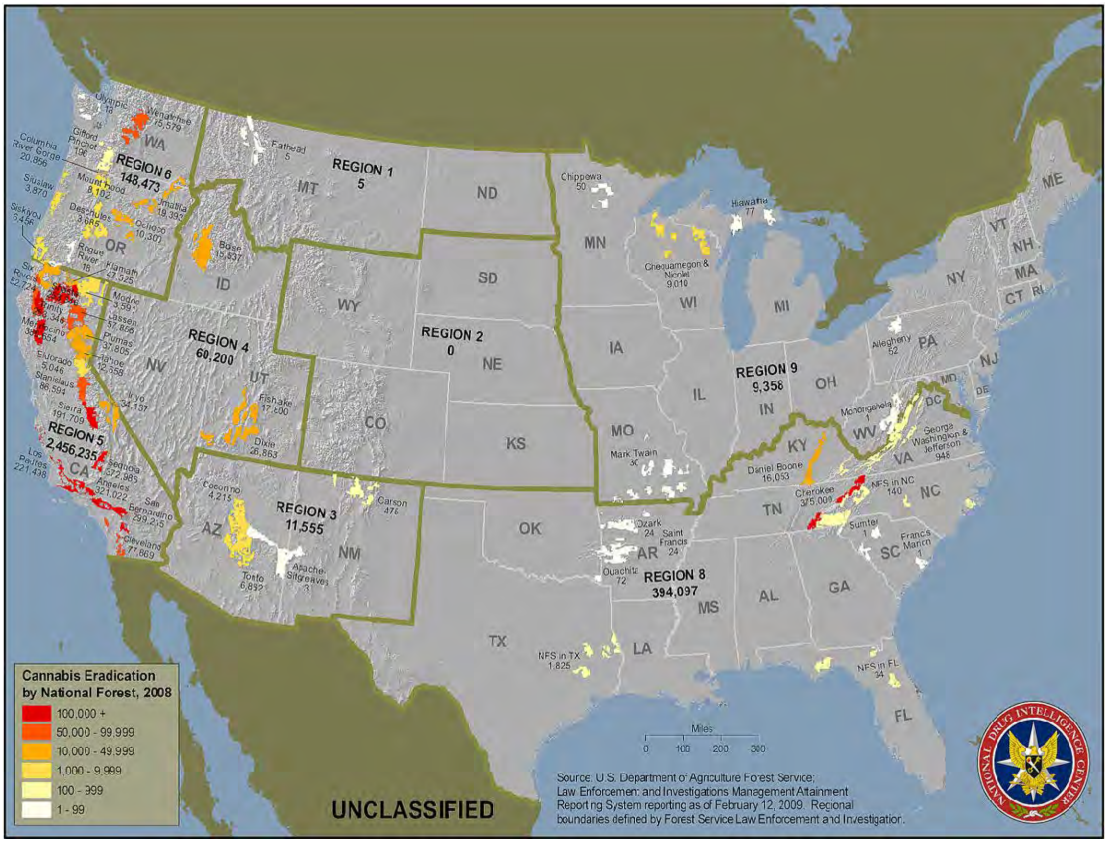
Any mortality of individual fishers from ARs could reduce the number of reproductive fisher within a population. If the distribution of ARs across the landscape was non-uniform (i.e., clustered) multiple fishers whose home ranges overlapped with an AR site could be exposed or killed; a situation that may effectively create population sinks, similar to trapping. The existence of population sinks could limit gene flow across the NRM by limiting fisher movement through some areas. However, due to the above discussion, it is unlikely that regulated use of strychnine-treated baits for pocket gopher control would have population level effects upon fisher.

Related Effects to Current Condition

To our knowledge, strychnine is legally being used in the NRM by two agencies, Idaho Department of Lands (IDL) (IDL 2017, entire) and United States Forest Service (USFS) (USFS 2017a, p. 1). Since 2006, IDL has averaged treating 279 acres of land annually with ARs within modelled fisher habitat (Sauder model) in the NRM (IDL 2017, p. 3). This amounts to treating 0.1 percent of IDL lands in modelled fisher habitat annually (IDL 2017, p. 3), or 0.8 percent of modelled fisher habitat annually (using the Sauder model area). Most of these applications were for pocket gopher control in new seedling plantations following clear cut harvest prescriptions (IDL 2017, p. 1). These areas are not likely used by fisher due to the absence of canopy cover following timber harvest, thus exposure of fisher to ARs is expected to be low. In addition, Environmental Protection Agency regulations for applying strychnine includes subterranean application, with no surface spillage permitted (IDL 2017, p. 5). Thus, the regulated nature of strychnine application further minimizes the chances of fishers contacting it in the NRM.

The USFS has used strychnine-treated oats since at least 2011 to protect primarily white pine, western larch and ponderosa pine seedlings from pocket gophers (USFS 2017a, p. 1). The USFS has treated 3,264 acres of land with strychnine since 2011. It is unclear how much the treatment areas overlap with modelled fisher habitat; however, the majority of treatments were on the Palouse Ranger District, which has a small amount of overlap with modelled fisher habitat. Treatments effects to fisher were considered in the proposed project analysis conducted by wildlife biologists and subterranean application was deemed sufficient to preclude any effects to fishers (USFS 2014a, p. 6; USFS 2014b, pp. 1-3). Given the limited amount of treated acres that overlap with modelled fisher habitat and the highly regulated, subterranean application of strychnine, effects to fisher from strychnine use on U.S. Forest Service lands appears low.

Illegal use of ARs (mainly distribution above ground) has been cited as a concern for fisher in the Pacific states (Gabriel et al. 2012, entire). Exposure of fishers to ARs in two California populations appears to be widespread and increasing (Figure 12; Gabriel et al. 2015, p. 7). The primary source of exposure of fishers to ARs in California appears to be above ground distribution of ARs at illegal marijuana grow sites (Gabriel et al. 2012, p. 12).



Source: U.S. Department of Agriculture Forest Service; Law Enforcement and Investigations Management Attainment Reporting System reporting as of February 12, 2009. Regional boundaries defined by Forest Service Law Enforcement and Investigation.

Figure 12. Number and distribution of illegal marijuana grow sites and plants per site in the Pacific states (California, Oregon, Washington) and the NRM (Idaho and Montana) as of 2008 (USDA 2009). Outlines on map are national forest boundaries, not grow site boundaries.

Recently, the presence of ARs was tested in 29 fishers that were incidentally trapped over a 5 year period (2011-2015) in central and northern Idaho (IDFG 2017c, p. 1). Nine of 29 (31 percent) samples showed the presence of at least one AR. Of the nine positive samples, five samples had quantifiable levels (i.e., greater than trace amounts) of at least one AR. Although lethal thresholds of AR concentration are not currently known, two of the 29 (7%) samples had concentrations of a second-generation AR that were consistent with lethal toxicosis observed in AR-exposed fisher in California (IDFG 2017c, p. 1). It is unknown whether the nine fisher that tested positive for ARs displayed any sublethal effects. Given the low incidence of presumed lethal effects and uncertainty regarding sublethal effects, we conclude that although ARs are likely affecting individual fisher in the NRM, the effect of ARs at the population level in the NRM is low.

It has been hypothesized that fishers in the NRM may be susceptible to exposure of ARs from illegal marijuana grows, similar to their conspecifics in California. However, prevalence of illegal marijuana grows appears to be substantially less in the NRM than in California (Figure 12). A 2017 query of a U.S. Forest Service law enforcement database indicated three illegal marijuana grows in the NRM in recent history, with no documented use of rodenticide (Byas 2017, pers. comm.). Similarly, other law enforcement officials corroborate the low incidence of known marijuana grows in the NRM (IDFG 2017c, p. 1). Low numbers of marijuana grows in the NRM was attributed to topography, climate and poor growing conditions (Staab 2017, pers. comm.). Given this information, it appears unlikely that the recent presence of ARs detected in some NRM fishers was from illegal marijuana grows.

Predation

Predation is a natural, ongoing ecological interaction between fisher and potential predators, including mountain lions (*Felis concolor*), bobcats, coyotes, and large raptors (Powell and Zielinski 1994, p. 25; Truex *et al.* 1998, pp. 80–82; Higley and Matthews 2009, p. 14; Wengert 2010). These species have coevolved in the NRM for about 4,000 years, thus these predatory interactions are not novel. Predatory pressure among coevolved species is not expected to change significantly through time, unless habitat conditions change that favor either fishers or fisher predators.

Individual effects

Individual fisher traversing areas of low canopy cover may increase their vulnerability to predation (Heinemeyer 1993, p. 26; Powell and Zielinski 1994, p. 62). Predation of fisher newly translocated to Montana was reported (Roy 1991, pp. 29, 35; Heinemeyer 1993, p. 26), but this was attributed to the relocation techniques used and fitness of the individual animals (Powell and Zielinski 1994, p. 62; Vinkey 2003, p. 34).

Population Effects

Fragmentation of suitable habitat could increase predation risk for fisher. Population level effects could include reduced numbers of fisher occupying suboptimal habitat that predisposes them to increased predation risk.

Related Effects to Current Condition

Much of the modelled fisher habitat in the NRM is contiguous or connected by forested areas with greater than 40 percent canopy cover (See Figure 8). This spatial arrangement of modeled habitat is expected to allow fisher to traverse most of the NRM and have adequate canopy cover from aerial predators and vertical escape cover from terrestrial predators. While predation on fisher is expected to occur in the NRM, the spatial arrangement and contiguous nature of the current modeled habitat are expected to preclude any disproportionate effects of predation on fisher survival. For these reasons, current effects of predation on fisher are expected to be similar to historical effects and are expected to be low.

3.6 Current Resiliency, Redundancy and Representation

As discussed in Chapter 1, for the purpose of this assessment, we define viability as the ability of the species to sustain populations in the wild over time. Using the SSA framework, we describe the species' viability by characterizing the status of the species in terms of its resiliency, redundancy, and representation (the 3Rs). Using various time frames and the current and projected levels of the 3Rs, we thereby describe the species' level of viability over time. Here we describe the current condition of the 3Rs for NRM fishers. We describe future condition in the following section.

To assess the current condition of the 3Rs for NRM fishers, we analyzed the number and distribution of modeled habitat patches at the home range scale (100 km^2) and MCA scale (2500 km^2) in the NRM. We used the number and distribution of 100 km^2 modeled habitat patches to describe the quantity of modeled habitat for individual fisher in the NRM. Low quantity modeled habitat was determined to represent less than 5 modeled habitat patches of 100 km^2 within the NRM, based on a minimum number of individuals needed to maintain a group of fishers (Olson et al. 2014, p. 93). Medium quantity modeled habitat was determined to represent 5 to 24 modeled habitat patches of 100 km^2 within the NRM. We reason that this range of modeled habitat patches is above the minimum estimated by Olson et al. 2014, but below the number needed (i.e., 25) to preclude the effects of inbreeding (i.e, 50 breeding individuals; Franklin 1980, entire). High quantity modeled habitat was determined to represent 25 or more modeled habitat patches of 100 km^2 based on the aforementioned minimum number of breeding individuals needed to preclude the effects of inbreeding (Franklin 1980, entire).

We used the number and distribution of 2500 km^2 modeled habitat patches to describe how contiguous current modelled habitat is in the NRM. A low degree of contiguity was determined to represent less than 1 MCA within the NRM, because less than one MCA would not be expected to support more than 50 breeding fishers, thus the potential effects of inbreeding may compromise long-term persistence (Franklin 1980, entire). Medium contiguity was determined to represent 1 to 9.9 MCAs within the NRM. We reason that this range of MCAs is above the minimum needed to preclude inbreeding effects, but below the number needed (i.e., 10) to effectively discount loss of genetic variability (i.e, 500 breeding individuals; Franklin 1980, entire). High contiguity was determined to represent 10 or more MCAs based on the aforementioned minimum number of breeding individuals needed to discount loss of genetic variability over time (Franklin 1980, entire).

Resiliency

As described in the Introduction of this SSA, resiliency describes the ability of populations to withstand stochastic events (arising from random factors). We can measure resiliency based on metrics of population health; for example, birth versus death rates and population size. In the absence of species-specific demographics, we evaluate resiliency based on modeled habitat characteristics across the geographical range. Highly resilient populations are better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities.

Modelled fisher habitat at both the home range scale and MCA scale are widely distributed across the NRM (Table 7). Wide distribution of habitat is advantageous for fishers because many of the stochastic disturbances expected to affect fishers and their habitat in the NRM (fire, etc.) are typically more localized in extent. The wide distribution of fishers (Figure 3) and modeled habitat across the landscape lowers the risk that one or several stochastic disturbances could disproportionately affect the majority of fishers within the NRM.

Connectivity between and among modeled habitat patches and fisher spatial units in the NRM appears high because of abundant and highly contiguous canopy cover. Movement of fishers along the east/west axis of the NRM is likely more limited because of several glaciated valleys and associated human development. However, multiple areas of suitable canopy cover remain and may facilitate fisher movement in the east/west direction to some degree. This connectivity is important because it allows fishers to access new habitats if stochastic disturbance displaces them or temporarily alters habitat in some areas. In addition, fishers are relatively good dispersers, given habitat with adequate canopy cover that facilitates fisher movement.

Fisher habitat is inherently resistant to stochastic events such as localized fire and drought. The effects of localized fire on fisher habitat are mediated by the wetter, maritime climate and diverse topography across much of the NRM, as evidenced by the longer fire return intervals that characterize most of the modelled fisher habitat. The presence of ash from the Mount Mazama eruption in the NRM also increases habitat resiliency to drought. The ashcap in the soil has a high water absorption and retention capacity that is important in mitigating moisture shortages for vegetation during periods of drought.

Redundancy

As described in the Introduction of this SSA, redundancy describes the ability of a species to withstand catastrophic events. Measured by the number of populations, their resiliency, and their distribution (and connectivity), redundancy gauges the probability that the species has a margin of safety to withstand or can bounce back from catastrophic events (such as a rare destructive natural event or episode involving many populations).

A large, regional wildfire (similar to the 1910 fires) is the most likely catastrophic event to affect fisher habitat in the NRM. Fishers in the NRM comprise one population, therefore there is no redundancy of populations. Within the NRM, there is redundancy of modelled habitat patches at the home range scale ($100km^2$; Table 7). In addition, two of the three fisher spatial units have 3 or more MCAs ($2,500km^2$; Table 7), thereby lowering the risk that even a large, catastrophic fire could eliminate all larger, contiguous habitat patches. What fishers lack in the form of redundant populations across the NRM appears to be at least partially mitigated by the widespread, yet largely connected, amount and distribution of modelled habitat patches of sufficient size to meet the life history needs of individual fishers and the population.

Representation

As described in the Introduction of this SSA, representation describes the ability of a species to adapt to changing environmental conditions. Representation can be measured by the breadth of genetic or environmental diversity within and among populations and gauges the probability that a species is capable of adapting to environmental changes. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment. In the absence of species-specific genetic and ecological diversity information, we evaluate representation based on the extent and variability of modeled habitat characteristics across the geographical range.

Fishers in the NRM have evolved in a dynamic landscape created by environmental change and associated disturbance regimes. Life history traits that have enabled fishers to survive changing environmental conditions include being a prey generalist and good disperser. Fishers can utilize a wide variety of prey, thereby minimizing the influence of changing environmental conditions on prey abundance and distribution. Fishers have been able to adapt to shifting habitat in the past as glacial ice sheets melted and habitat distribution changed. Currently, much of the NRM is heavily forested with relatively contiguous canopy cover, which facilitates fisher movement across the landscape. A native genotype is still present in the NRM, along with individuals with genetic signatures presumably from past reintroductions. Multiple modeled habitat patches capable of supporting individual fisher (100km^2) are represented in all fisher spatial units (Table 7). In addition, two of the three fisher spatial units currently have 3 or more MCAs (2,500km^2; Table 7)). Overall, representation of suitable modeled fisher habitat across the NRM appears high.

Table 7. Assessment of current condition (quantity and distribution) of modeled habitat for individual fisher (100 km^2) and the NRM population (2500 km^2), by fisher spatial unit and totaled across the northern rocky mountains. Numbers in parentheses indicate number of each respective modeled habitat unit and fisher spatial unit combination. Criteria for determining current status of modeled habitat condition of (100 km^2) in the NRM: **low** equals <5, **moderate** equals 5 to 24, and **high** equals 25 or greater. Criteria for determining current status of modeled habitat condition (2500 km^2) in the NRM: **low** equals <1, **moderate** equals 1 to 9.9, and **high** equals 10 or greater.

		NW		**NE**		**S**		**NRM Totals**	
	Timestep	**#100km^2**	**#2500km^2**	**#100km^2**	**#2500km^2**	**#100km^2**	**#2500km^2**	**#100km^2**	**#2500km^2**
Scenario	**Current**	**(93)**	**(3.3)**	**(17)**	**(0.6)**	**(128)**	**(4.3)**	**(238)**	**(8.2)**

CHAPTER 4. FUTURE CONDITION

In this chapter, we project effects of potential stressors on fisher and their modeled habitat into the future by developing scenarios that capture a range of possible outcomes. We then predict future cause/effects of potential stressors on fisher and their modeled habitat and discuss viability related to each future scenario. This requires some knowledge or estimate of the future trajectory of current or future potential stressors. We use the best available science to help develop scenarios based on future trajectories of potential stressors (Table 8).

Table 8. Characteristics of potential stressors on fisher and their modeled habitat in the northern rocky mountains.

Potential Stressor	Cause	Future trajectory	Applicable timeframe	Reference
Climate change	Greenhouse gas emissions	Increase	~75 years	IPCC 2014 Olson et al. 2014
Development	Human population growth	Increase	~15 years	Stein et al. 2007
Forestry	Multiple use mandate	Stable		USFS 2017b
Fire	Natural/man-caused	Increase	~50 years	Krawchuk et al. 2009 Westerling et al. 2006
Trapping	Recreational pursuit	Stable		IDFG 2017a MFWP 2017
Poisoning	Forestry/ Unknown	Stable		USFS 2017a
Predation	Ecological interaction	Stable		USFWS 2016

4.1 Climate Change

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (e.g., Meehl *et al*. 2007, entire; Ganguly *et al*. 2009, pp. 11555, 15558; Prinn *et al*. 2011, pp. 527, 529). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2050 (IPCC 2014, p. 11; Ray *et al*. 2010, p. 11). Although projections of the magnitude and rate of warming differ after about 2050, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (IPCC 2014, p. 57; Meehl *et al*. 2007, pp. 760–764 and 797–811; Ganguly *et al*. 2009, pp. 15555–15558; Prinn *et al*. 2011, pp. 527, 529). (See IPCC 2014, pp. 9–13, for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation.)

Olson et al. 2014 modelled fisher habitat under two future emissions scenarios; Scenario A, which represents an increasing human population, more regional economic development, and thus higher carbon emissions, and Scenario B, which represents continuing but slower human population growth, less regional economic development, an emphasis on environmental protection and thus lower carbon emissions (Olson et al. 2014, p. 92). These scenarios were chosen to provide an upper and lower bound of emissions in which to model fisher habitat in the future, projected at years 2030, 2060 and 2090 (Olson et al. 2014, p. 92). The Service utilizes both Scenarios A and B from Olson 2014 in our analysis of predicting future conditions and potential effects on fishers and their modeled habitat. Based on expert opinion (Olson 2017a, pers. comm.) and recent trajectory of emissions (IPCC 2014, p. 9), Scenario A is believed to be the most likely future scenario to occur.

Under climate Scenario A, we conclude that fisher modeled habitat is expected to shift to the north and east (Figure 13; Olson et al. 2014, p. 95). This climate shift is expected to increase the amount of 100 km^2 modeled habitat patches available to fishers by 10-124 patches across the NRM, depending on timestep (Table 9). In addition, the number of MCA's is expected to be maintained at 7 by 2030 and almost double by 2090 (Table 9). Most of the predicted gains in 100 km^2 modeled habitat patches and MCAs are expected to occur in the NE and S spatial units (Table 9).

Under climate Scenario B, fisher modeled habitat is expected to shift to the north and east, similar to Scenario A, but at later timesteps (Figure 13; Olson et al. 2014, p. 95). This climate shift is expected to generally decrease the amount of 100 km^2 modeled habitat patches available to fisher by 10-34 patches across the NRM, depending on timestep (Table 9). In addition, the number of MCA's is expected to decline by 1-2 across the NRM (Table 9). Most of the predicted losses in 100 km^2 modeled habitat patches and MCAs are expected to occur in the S spatial unit (Table 9).

One of the limitations of the Olson climate model is that it does not account for any lag time between when suitable climatic conditions are present and when suitable vegetation conditions are present for fishers. Because of this limitation, we structured one of our analyses to explore how much current modeled habitat remains suitable through the different future timesteps under both emissions scenarios (Table 10). Any areas of current modeled habitat that remain suitable

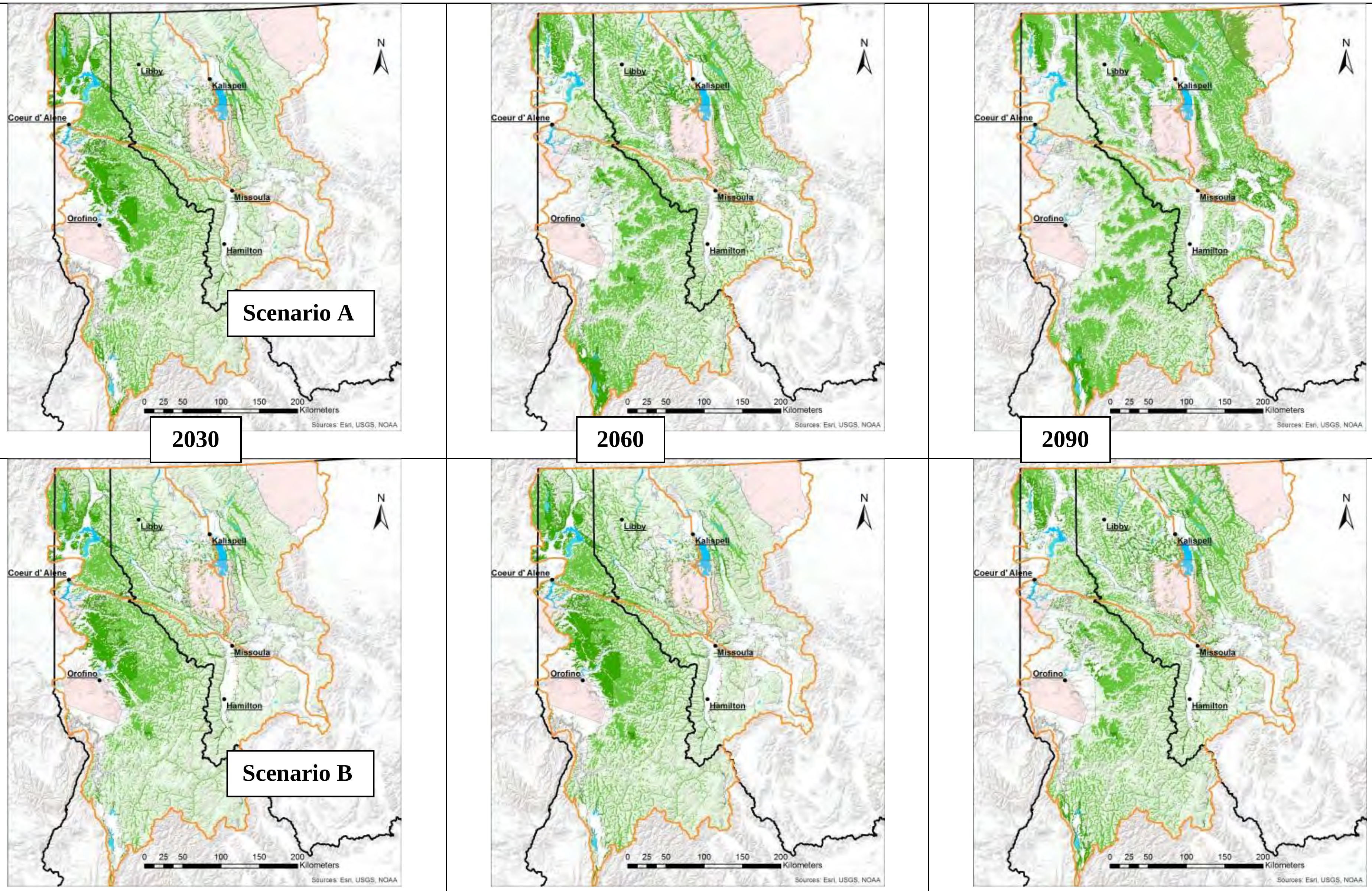


Figure 13. Modelled fisher habitat predicted by the Olson climate model for three future timesteps (years 2030; first column, 2060; middle column, 2090; third column) and two emissions scenarios (A = more emissions; top row, B = less emissions; bottom row) (Olson et al. 2014). Light green overlay is Federal land ownership (ESRI 2017). Pink polygon overlay is tribal reservations (United States Census Bureau 2016).

Table 9. Modeled habitat metrics and potential fisher capacity (PFC) calculated for fisher spatial units at future timesteps for the Olson climate model (Olson et al. 2014). Green shading depicts an increase relative to current condition. Red shading depicts a decrease relative to current condition.

		NW			NE			S			NRM Totals		
	Timestep	#100km^2	[a]#2500km^2	PFC	#100km^2	[a]#2500km^2	PFC	#100km^2	[a]#2500km^2	PFC	#100km^2	#2500km^2	PFC
Scenario	Current	93	3.3	465	17	0.6	85	128	4.3	640	238	8.2	1190
A-higher emission	2030	83	2.9	415	18	0.7	90	147	5.0	735	248	8.6	1240
	2060	87	3.3	435	54	2.0	270	150	5.6	750	291	10.9	1455
	2090	103	3.9	515	139	5.6	695	150	5.7	750	392	15.3	1960
B-lower emission	2030	78	2.7	390	13	0.5	65	113	3.9	565	204	7.1	1020
	2060	79	2.7	395	14	0.5	70	129	4.2	645	222	7.4	1110
	2090	80	2.7	400	51	1.8	255	97	2.9	485	228	7.4	1140

[a]Only values greater than 0.5 are reported for contiguous habitat patches ≥ 2500 km^2.

Table 10. Number of minimum critical areas that are currently modelled fisher habitat and amount which is modelled in future timesteps, by spatial unit and emission scenario.

	Timestep	NW[a]	NE[a]	S[a]	Totals
Scenario	Current	3.3	0.6	4.3	8.2
A-higher emission	2030	2.8	0.6	4.4	7.8
	2060	1.6	0.6	1.6	3.8
	2090	1.1	0.6	1.1	2.8
B-lower emission	2030	2.6	0.5	3.9	7
	2060	2.7	0.5	4.6	7.8
	2090	1.6	0.6	1.9	4.1

[a]Only values greater than 0.5 are reported for contiguous habitat patches ≥ 2500 km^2.

through multiple future timesteps would represent transitional areas where fisher could persist as vegetative changes transition in response to climatic changes at later timesteps.

Our analysis of the current number of MCAs that are maintained as suitable modeled habitat through later timesteps under both Scenarios A and B indicate at least 1 MCA is predicted to remain suitable under both emissions scenarios in the NW and S fisher spatial units to 2090 (Table 10). These MCAs may provide refugia areas for fisher, if lag times between suitable climate conditions and suitable vegetation conditions are considerable. It is unclear how long suitable vegetation conditions may lag behind climatic conditions. However, we note that areas in the north and east NRM where modelled fisher habitat is predicted to shift currently contain modelled habitat, in varying quantities and arrangements. This is important for two reasons; 1) having currently modelled habitat proximate to areas where habitat is expected to expand into provide fisher with transition zones to aid in adapting to changing habitat conditions, and 2) seed sources for facilitating vegetative shifts as a result of climatic shifts are already present in areas where much of the modelled habitat is predicted to transition.

4.2 Development

Future residential development in the NRM adjacent to public lands is expected to increase by 10 to 42 percent by 2030 (Stein et al. 2007, p. 8). Much of the future residential development is expected to occur in the glaciated valley bottoms of the NRM. These areas were likely not occupied by fisher historically due to a natural lack of canopy cover. Thus, overlap between the majority of expected residential developments and modelled fisher habitat is expected to be small. Residential developments currently do not occur on Federal land and are not expected to in the future. Given that the majority of current and future modelled fisher habitat is on Federal land (Table 11), the effect of future residential development on fisher habitat is expected to be low.

Table 11. Percent of modelled fisher habitat occurring on Federal land and percent change from current condition by emissions scenario and timestep in the NRM (Olson et al. 2014).

Scenario	Timestep	Percent federal land	Percent change relative to current
A	2030	78%	+1%
	2060	86%	+9%
	2090	87%	+10%
B	2030	77%	0%
	2060	77%	0%
	2090	88%	+11%

4.3 Forestry

We expect the current timber management and silviculture activity to continue on national forest lands guided by forest management plans. The effects of present and future forest management and timber harvest on the capacity of the NRMs to support fisher may be influenced by many factors, including the location, scale, and juxtaposition of treatments to previous disturbances, the suitability of an area to provide fisher habitat under natural conditions and the habitat needs of fisher. An analysis of fisher habitat needs is incorporated into forest plans in the NRM under the old and new forest planning rules (NRMFID, p. 17). National forest lands that support fisher today reflect natural processes and silviculture actions spanning numerous planning periods as well as actions taken before comprehensive national forest management was mandated in 1976 (16 U.S.C 1601–1614). Given the history of forest management and planning, we do not expect significant changes in the availability of mature forest habitats through future forest planning cycles.

Fisher continue to occupy most of its presumed historical range, despite habitat alterations due to forestry practices that have occurred, although fisher densities may be different. Fishers in the NRM have been observed to use roadless areas of forests, national forest lands managed for multiple purposes, and State forests and industrial forests managed primarily for commercial timber production (Sauder and Rachlow 2014, pp. 80-81). We expect that fisher use of lands managed for timber production or multiple uses will continue in the future under conditions fostered by the continuance of current management.

4.4 Fire

Climate model projections indicate decreased snowpack, earlier snowmelt, and increasing temperatures contributing to longer fire seasons (Krawchuk et al. 2009, p. 7; Westerling et al. 2006, p. 943). Moisture patterns are more difficult to predict than temperature (Global Climate Change Impacts 2009, p. 135; Dai 2011, p. 16). Because many climate models predict higher precipitation levels associated with climate warming, the interaction between precipitation and temperature increase can be quite complex. If temperatures increase without compensating moisture patterns or amounts, the predicted warmer springs and summers could produce conditions favorable to the occurrence of large fires in the future, regardless of past trends (Krawchuk et al. 2009, p. 9; Westerling et al. 2006, p. 943). If this occurs, increased fire frequency and intensity in forests could increase the likelihood of direct fisher mortality, temporarily diminish the capacity of the landscape to support fisher, and temporarily decrease connectivity across the NRM.

Despite potential increases in frequency and severity of fires in the future in the NRM, negative effects from fire will be temporary and some effects may be beneficial in the long-term.

Fires in the NRM promote heterogeneity and vegetative mosaics preferred by fishers. While more disturbance may occur in the NRM as a result of increased frequency of fire in the future, the current and predicted future distribution of modelled habitat patches remains widespread. In addition, fisher currently use burned areas shortly post-fire (Hanson 2013 in Hanson 2015, p. 499; Hanson 2015, p. 499). We have no information suggesting that fisher use of burned areas will change in the future. For these reasons, we conclude that the future effects of fire on NRM fisher are low.

4.5 Trapping

Future trapping efforts in the NRM are expected to fluctuate with pelt prices, similar to past trends (Figure 14), but remain relatively consistent with current levels, on average. Therefore, trapping scenario number 2 (See Chapter 3, p. 43) is expected to be the most likely trapping scenario to represent average future trapping effort.

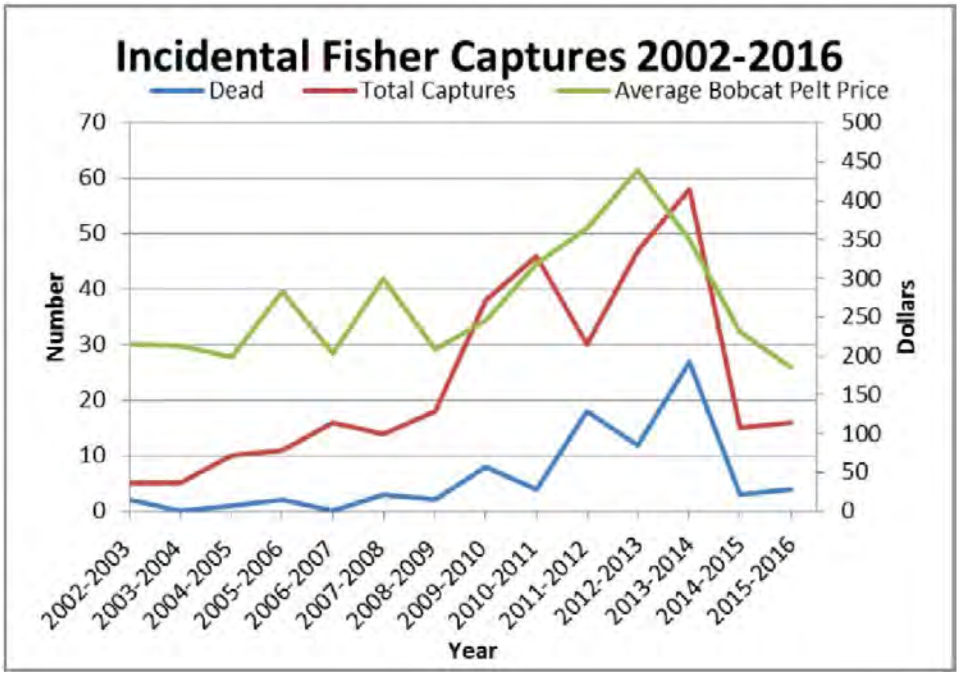


Figure 14. Relationship between trapping effort and average price of bobcat pelts in Idaho, 2002-2016 (IDFG 2017a).

Under trapping scenario 2, the percentage of future potential fisher capacity trapped varies from 1.6 to 3.0 percent. For climate Scenario A, trends in percentage of future potential fisher capacity that are trapped decline for all timesteps, relative to current (Table 12). For climate Scenario B, the percentage of fisher capacity trapped increases from current to 2030, then decrease in all future timesteps back to approximately the current level by 2090 (Table 12).

4.6 Poisoning

The legal use of strychnine in forestry management is expected to continue in the future. The amount of modeled fisher habitat overlapping areas with strychnine use in the future is unknown, but is expected to be small, based on current trends on both IDL and USFS lands (IDL 2017, p. 3; USFS 2017a, p. 1). Subterranean application of strychnine and use in areas with little canopy cover are expected to continue to limit the risk of fisher to strychnine exposure. Therefore, the effect of legal use of strychnine on fisher in the NRM is expected to continue to be low.

Table 12. Percentage of potential fisher capacity trapped in the NRM for trapping scenario 2, by emissions scenario and timestep.

	Timestep	Trapping #2
Scenario	Current	2.6
A	2030	2.5
	2060	2.1
	2090	1.6
B	2030	3.0
	2060	2.8
	2090	2.7

Although the source of recently detected ARs in the NRM is unknown at this time, we presume use of ARs will continue in the future. The future prevalence and concentrations of ARs in NRM fisher will depend on the scope and intensity of future AR use. We have no information indicating the scope and intensity of AR use will increase in the future. However, with the current low prevalence of samples with purported lethal concentrations in the NRM, effects to fisher from AR use are expected to continue to be low.

4.7 Predation

Predation is expected to continue to be part of the ecological interactions between NRM fisher and potential predators in the future. Modelled fisher habitat is expected to be more fragmented in parts of the NRM than it is currently (Olson et al. 2014, p. 94). Greater fragmentation might be expected to increase predation on fishers, as they may be forced to travel longer distances through habitat with lower canopy cover or vertical escape cover. However, while fisher modeled habitat is expected to become more fragmented in some areas, other areas are expected to become more contiguous (see NW and NE fisher spatial units at later timesteps in Figure 13). We conclude that predation on fisher may increase in the S spatial unit as modeled habitat becomes more fragmented, but any increase in predation in the S spatial unit could be counteracted by reduced predation in the NW and NE spatial units where modeled habitat is expected to become more contiguous. Therefore, although we expect predation on fisher to continue in the NRM in the future, the population level effect is expected to be low.

4.8 Summary of Future Scenarios

We developed two overall Future Scenarios based on best available science to synthesize the effects of all potential stressors on viability of NRM fisher. These two scenarios incorporate the plausible future trajectories of potential stressors from Table 8 and below we summarize their potential effects on NRM fisher (Table 13).

Future Scenario 1 is characterized by higher greenhouse gas emissions than Scenario 2 (but emissions for both scenarios are expected to increase from current) and is currently considered the most likely scenario to occur (Table 13). Increased emissions are expected to shift climate conditions suitable for fisher habitat to the north and east in the NRM, resulting in more modeled future fisher habitat in the NW and NE spatial units.

Concurrent with this shift, more modeled future fisher habitat is expected to occur on Federal land. Increases in the amount of modeled future fisher habitat correspond with a decrease in the percentage of fisher potential capacity that is trapped annually. Frequency of fire is expected to increase under Scenario A, but not act at the population level. Prevalence of forestry, poisoning, and predation are expected to remain stable, with low effects on fisher in the NRM.

Future Scenario 2 is characterized by lower greenhouse gas emissions than Future Scenario 1 (Table 13). Decreased emissions are expected to shift climate conditions suitable for fisher habitat to the north and east in the NRM, at later timesteps than Future Scenario 1. Amount of modeled fisher habitat on Federal land is expected to remain similar to current condition, and increase by 2090. Small decreases in the amount of modeled future fisher habitat correspond with small increases in the percentage of fisher potential capacity that is trapped annually. Frequency of fire is expected to increase under Future Scenario 2, but not act at the population level. Prevalence of forestry, poisoning, and predation are expected to remain stable, with low effects at the population level in the NRM.

Table 13. Summary characteristics and modeled habitat metrics of two overall future scenarios considered in analyzing future viability of fisher in the northern rocky mountains.

				Modeled Habitat				Trapping			
Overall Scenarios	Emissions	Amount	Distribution	$100km^2$	$2500km^2$	% Fed Land	Fire	PFC* Ratio	Forestry	Poisoning	Predation
1	+	+	Shift N and E	+	+	+	+	-	Stable	Stable	Stable
2	+	-	Shift N and E	-	-	Stable/+	+	+	Stable	Stable	Stable

*PFC = Potential Fisher Capacity

4.9 Future Resiliency, Redundancy, Representation

Similar to current condition in Chapter 3, we assess the future condition of the 3Rs for NRM fishers by analyzing the number and distribution of modeled habitat patches at the home range scale (100 km^2) and MCA scale (2500 km^2) among fisher spatial units in the NRM at three future timesteps (years 2030, 2060 and 2090) and under two future scenarios incorporating stressor trajectories derived from the scientific literature. We used the same numeric criteria to characterize quantity of both 100 km^2 and 2500 km^2 totaled across the NRM as was used for assessing current condition in Chapter 3.

Resiliency

Future Scenario 1-Modelled habitat for fisher is expected to continue to be widely distributed across all three fisher spatial units in the NRM in the future (Table 14). Modeled habitat shifts to the north and east are expected to occur, and fisher are expected to adapt to habitat shifts because: (1) they are currently present in all three fisher spatial units, (2) they have good dispersal capability, given adequate canopy cover, (3) canopy cover is expected to be across much of the NRM for dispersal, and (4) multiple current MCAs will remain suitable through future time steps, creating transition zones between currently modelled habitat and predicted future habitat.

Increased fire frequency in the future may temporarily decrease modeled habitat for fisher in the NRM. However, the continued widespread distribution of modelled fisher habitat in the NRM lowers the risk that fire will disproportionately affect fisher at the population level. In addition, stochastic events such as fire may have long-term positive effects on fisher habitat by creating mosaic patterns and foraging areas that fisher select for in the NRM. Fisher are prey generalists and have evolved with multiple prey species in a dynamic environment.

Modeled fisher habitat is expected to retain its inherent resilience to stochastic events such as localized fire and drought in the future. The effects of localized fire on fisher habitat are expected to continue to be mediated by the wetter, maritime climate and diverse topography across much of the NRM. The continued presence of ash from the Mount Mazama eruption, both in currently modelled habitat and in areas where habitat is expected to shift, is expected to maintain resiliency of modeled fisher habitat to drought into the future.

We expect these factors will maintain the resilience of fisher in the NRM by lowering the risk that one or several stochastic disturbances could disproportionately affect the majority of fisher within the NRM in the future. Under Scenario 1, resiliency of fisher and their modeled habitat in the NRM is expected to remain high in the future (Table 14).

Scenario 2-Modeled fisher habitat is expected to continue to be widely distributed across the NRM in the future, although not as widespread as under Scenario 1 (Table 14). Modeled habitat shifts to the north and east are expected to occur at later timesteps than in Scenario 1. However, fisher are still expected to adapt to habitat shifts for the same reasons outlined in Scenario 1.

Increased fire frequency in the future may have a greater effect on modeled fisher habitat under Scenario 2 than Scenario 1 because there is expected to be less suitable modeled habitat in the future. However, the continued widespread distribution of suitable modeled fisher habitat in the NRM lower the risk that fire or other stochastic events will disproportionately affect fisher at the population level. Potential positive long-term effects of fire may benefit fisher under Scenario 2 similar to Scenario 1.

Similar to Scenario 1, modeled fisher habitat is expected to retain its inherent resilience to stochastic events such as localized fire and drought in the future, due to the wetter, maritime climate, diverse topography across much of the NRM and continued presence of ash from the Mount Mazama eruption. Resiliency, under Scenario 2, is expected to be reduced compared to Scenario 1, but remain similar to current condition through all timesteps into the future (Table 14).

Table 14. Assessment of future condition (quantity and distribution) of modeled habitat for individual fisher (100 km^2) and the NRM population (2500 km^2), by fisher spatial unit and totaled across the northern rocky mountains for future timesteps and two future scenarios. Numbers in parentheses indicate number of each respective modeled habitat unit and fisher spatial unit combination. Criteria for determining current status of modeled habitat condition of (100 km^2) in the NRM: **low** equals <5, **moderate** equals 5 to 24, and **high** equals 25 or greater. Criteria for determining current status of modeled habitat condition (2500 km^2) in the NRM: **low** equals <1, **moderate** equals 1 to 9.9, and **high** equals 10 or greater.

		NW		NE		S		NRM Totals	
	Timestep	#100km^2	#2500km^2	#100km^2	#2500km^2	#100km^2	#2500km^2	#100km^2	#2500km^2
Scenario	Current	**(93)**	**(3.3)**	**(17)**	**(0.6)**	**(128)**	**(4.3)**	**(238)**	**(8.2)**
1	2030	**(83)**	**(2.9)**	**(18)**	**(0.7)**	**(147)**	**(5.0)**	**(248)**	**(8.6)**
	2060	**(87)**	**(3.3)**	**(54)**	**(2.0)**	**(150)**	**(5.6)**	**(291)**	**(10.9)**
	2090	**(103)**	**(3.9)**	**(139)**	**(5.6)**	**(150)**	**(5.7)**	**(392)**	**(15.3)**
2	2030	**(78)**	**(2.7)**	**(13)**	**(0.5)**	**(113)**	**(3.9)**	**(204)**	**(7.1)**
	2060	**(79)**	**(2.7)**	**(14)**	**(0.5)**	**(129)**	**(4.2)**	**(222)**	**(7.4)**
	2090	**(80)**	**(2.7)**	**(51)**	**(1.8)**	**(97)**	**(2.9)**	**(228)**	**(7.4)**

Redundancy

Scenario 1- Redundancy of modeled habitat patches capable of supporting multiple fisher (100km^2) are expected to increase under Scenario 1 and be widely distributed among all fisher spatial units in the future (Table 14). The number of MCAs (2500km^2) is also expected to increase across the NRM in the future, with MCAs being well-distributed among fisher spatial units (Table 14). The increase and distribution of home ranges and MCAs across the NRM currently and in the future are expected to minimize the risks to fisher and their modeled habitat from catastrophic wildfire. Thus, under Scenario 1, redundancy is expected to remain high (Table 13).

Scenario 2- Fewer modeled habitat patches capable of supporting multiple fishers (100 km^2) are expected in the future under Scenario 2 than Scenario 1; however, modeled habitat patches are expected to remain well distributed among fisher spatial units (Table 14). The number of MCAs (2500 km^2) is expected to decrease slightly across the NRM, but remain near current levels (Table 14). Redundancy of MCAs among fisher spatial units is expected to be moderate, with two of three fisher spatial units containing multiple MCAs at most timesteps. The distribution of home ranges and MCAs across the NRM currently and in the future are expected to minimize the risks to fisher and their habitat from catastrophic wildfire. While decreases in both home ranges and MCAs are predicted at most time steps relative to current condition, the losses are moderate when compared to current levels. Thus, under Scenario 2, redundancy is expected to be moderate in the future (Table 14).

Representation

Scenario 1-Genetic diversity of fisher in the NRM is unknown, however four different genetic haplotypes exist in the NRM. The native haplotype, along with three other haplotypes presumed to be from historical fisher reintroductions, indicate some level of genetic variability within the fisher population in the NRM and are expected to persist in the future. For modeled habitat, suitable patches (both 100 km^2 and 2500 km^2) are expected to increase in all three fisher spatial units in the future, thus increasing representation in the future despite changing environmental conditions. Thus, representation is expected to remain high under Scenario 1 in the future (Table 14).

Scenario 2- The four existing genetic haplotypes in the NRM are expected to persist in the future under Scenario 2, similar to Scenario 1. While the number of suitable modeled habitat patches (both 100 km^2 and 2500 km^2) are expected to be less than in Scenario 1, adequate distribution of patches among fisher spatial units is expected to remain into the future. Thus, representation under Scenario 2 is expected to remain high in the future (Table 14).

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Appendix A

Table A1. Assumptions made for models and analyses used in the northern rocky mountains fisher species status assessment report.

Analysis	Assumption
Olson climate model	The Olson climate model accounts for the finer scale, vegetative features that NRM fishers select for at second, third, and fourth order habitat selection.
Olson climate model	Suitable climate conditions for NRM fishers will produce suitable vegetation conditions for fishers.
100 km^2 habitat patch	Fishers in the NRM are occupying modelled habitat patches that are entirely contiguous and equal to or greater than the approximate size of a male home range (100 km^2).
2500 km^2 habitat patch	Approximately 50 adult fishers are occupying modelled habitat patches in the NRM that are entirely contiguous and equal to or greater than 2500 km^2.
Potential Fisher Capacity	Average density of fishers in the NRM in a typical male home range (100 km^2) is one male, one female, and two juveniles.